TEMPPO Designer (IDATG)

Version 16.0

User´s Guide - Part I

How to Do Model-based Testing

July 2014

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1 Introduction

This manual describes the use of **TEMPPO Designer** Version 16.0. The tool is also called **IDATG** (Integrating Design and Automated Test Case Generation). For historical reasons and to avoid confusion with other components of the TEMPPO framework, only the term IDATG will be used in the following.

1.1 Validity of the manual

- This user manual is valid for IDATG V16.0.
- For information about the test-execution tools QuickTest, Ranorex, SilkTest, TestPartner, and WinRunner please refer to the respective user guides.

1.2 Relationship with other documents

- The second part of this User's Guide contains a detailed description of the windows in the IDATG user interface.
- A tutorial containing a step-by-step description of the IDATG method is also available.
- The tool IDATG provides online help that gives a detailed description of its functionality. The help text is based on this document.

1.3 Target group

This user manual is recommended for

- Test managers
- Test case designers
- Testers
- GUI Designers

What prior knowledge is the reader expected to have?

- Basic knowledge about: GUI design, task modeling, state-transition diagrams, test case design.

1.4 Structure of the manual

Chapter 1 contains some general facts about this manual.
Chapter 2 gives an overview of the IDATG method.
Chapter 3 deals with the installation procedure.
Chapter 4 explains the recommended workflow for creating graph-oriented test cases.
Chapter 5 explains the additional steps for creating data-oriented test cases.
Chapter 6 presents the benefits of random testing.
Chapter 7 explains the workflow for transition testing.
Chapter 8 deals with the peculiarities of testing graphical user interfaces.
Chapter 9 shows how multiple users can work on the same IDATG project.
Chapter 10 deals with the test case generation and execution process.
Chapter 11 describes the interfaces to test management.
Chapter 12 describes the formal language for defining events, conditions and actions.
A bibliography and a glossary conclude the user guide.

2 Overview of IDATG

- The IDATG (Integrating Design and Automated Test Case Generation) specification technique and tool is designed for the **specification of hierarchical sequence diagrams** and the **automated generation of test cases**.
- IDATG includes a set of editors for the formal specification of test sequences, test data, semantic constraints and user interfaces.
- The formal specification can be exported in XML, HTML or MS WinWord format.
- The IDATG-tool is open for different GUI-builders and platforms. GUI-information can be recorded directly from the screen. GUI objects can be linked to steps in the sequence diagrams simply by pointing at a screenshot.
- A powerful test case generator is able to create test scripts in a general format that can be converted for GUI test execution tools like QuickTest, Ranorex, SilkTest, TestPartner, and WinRunner. For API testing, it is possible to export the generated test cases as plain text e.g. as Tcl script..
- IDATG can be easily integrated with test management tools.

2.1 Supported Test Categories

IDATG is used for **black-box testing**, which means that the source code of the application is not required for testing. While the original purpose of IDATG has been the support of automated GUI testing, the tool can also be applied for different forms of API testing. The following types of test cases are generated:

- **Graph-oriented** test cases based on hierarchical sequence diagrams ("task model"). This method can be used for both GUI and API testing. By defining frequently performed test sequences as "building blocks", the maintainability and clearness of the specification can be significantly improved. IDATG supports both step coverage (C0) and step connection coverage (C1).
- **Data-oriented** test cases that aim at covering a set of valid and/or invalid data records. Test data can be defined manually, be imported from an external source, or be generated automatically according to the equivalence class or CECIL method. Subsequently, individual data fields can be connected with steps in a sequence diagram.
- **Random** test cases that are an important complement to test cases created with systematic test design methods. Typically, random test cases are rather long and tend to discover defects that are hard to detect with other methods (e.g. memory leaks, crashes caused by unforeseen user behaviour etc.)
- **Transition** test cases that cover the dynamics and semantics of the GUI. They can be used for stand-alone testing of single dialogs or for integration testing.

2.2 Supported Platforms

IDATG runs under Microsoft Windows (98/NT/2000/XP/Vista/7). However, the test scripts that are generated by IDATG can be executed under other operating systems as well.

The IDATG GUI Spy currently supports the following GUI builders:

- Visual C++, Visual Basic, .NET, HTML, Java, Delphi.

Data for other GUI builders can be imported from QuickTest object repositories. This includes:

- SAP, WPF, Oracle

Please note that in addition to IDATG a test execution tool is required that has to support the desired platform and GUI builder.

2.3 Basic Terms

Before continuing to explore this user guide, it is necessary to understand a few basic terms that are used throughout the following:

2.3.1 Task

Originally, the term **task** was used in IDATG for sequence diagrams that represented the workflow of typical user tasks. Today, these sequence diagrams are used in a more general way and can represent any sequence of steps that is relevant to testing.

We can distinguish 2 types of tasks:

- A sequence diagram depicting a complete test scenario is called **use case task**. During the generation, IDATG starts at the initial step of the use case task and tries to find a valid path to its end.
- Use case tasks usually consist of **building block tasks** that can be re-used and parameterized. Naturally, building blocks can contain other building blocks.

2.3.2 Step

The basic term of the IDATG language is the **step**. A step can either be an atomic step containing a single test instruction or represent an entire building block task. Atomic steps can be described by the following information:

- The **test command**. For GUI testing, the test command is also called **event**, because it usually represents a user input that triggers the step (e.g. a mouse click).
- The semantic **conditions** that must be fulfilled before the step can be executed (e.g., a certain button must be enabled).
- The **actions** executed during the step (e.g. a window opens or a button becomes disabled).
- For GUI testing, the **start and destination window** of the step (in other words, the focus position before and after the step).
- For API testing, it may be necessary to define the **test driver** that will execute the test command.
- The **expected results** are defined indirectly by introducing verify steps that contain test commands that compare the actual results with the expected ones.

During your work with IDATG, you will encounter different forms of steps:

- **Task Steps**
  For graph-oriented and data-oriented testing, the sequence of steps is determined by you. You can define it in a task flow diagram.
- **Transitions**
  IDATG also supports another test method called transition testing in which you do not define a certain step sequence. You just enter individual steps and IDATG determines a proper sequence based on the semantic information you provide for the steps (only applicable for GUI testing)
- **Test Steps**
  IDATG can generate automatically various types of test cases that - naturally - also consist of steps. Like tasks, test cases can be displayed as a sequence diagram.

2.3.3 Window

The term **window** is used here as equivalent for GUI object. Thus, dialogs, buttons, input fields, static texts etc. are all equally seen as windows. Each window may contain an unlimited number of child windows. This point of view corresponds to the structure of most operating systems (e.g. MS Windows).

2.4 Test Process using IDATG

The following diagram shows the sequence of activities when applying IDATG in a project.

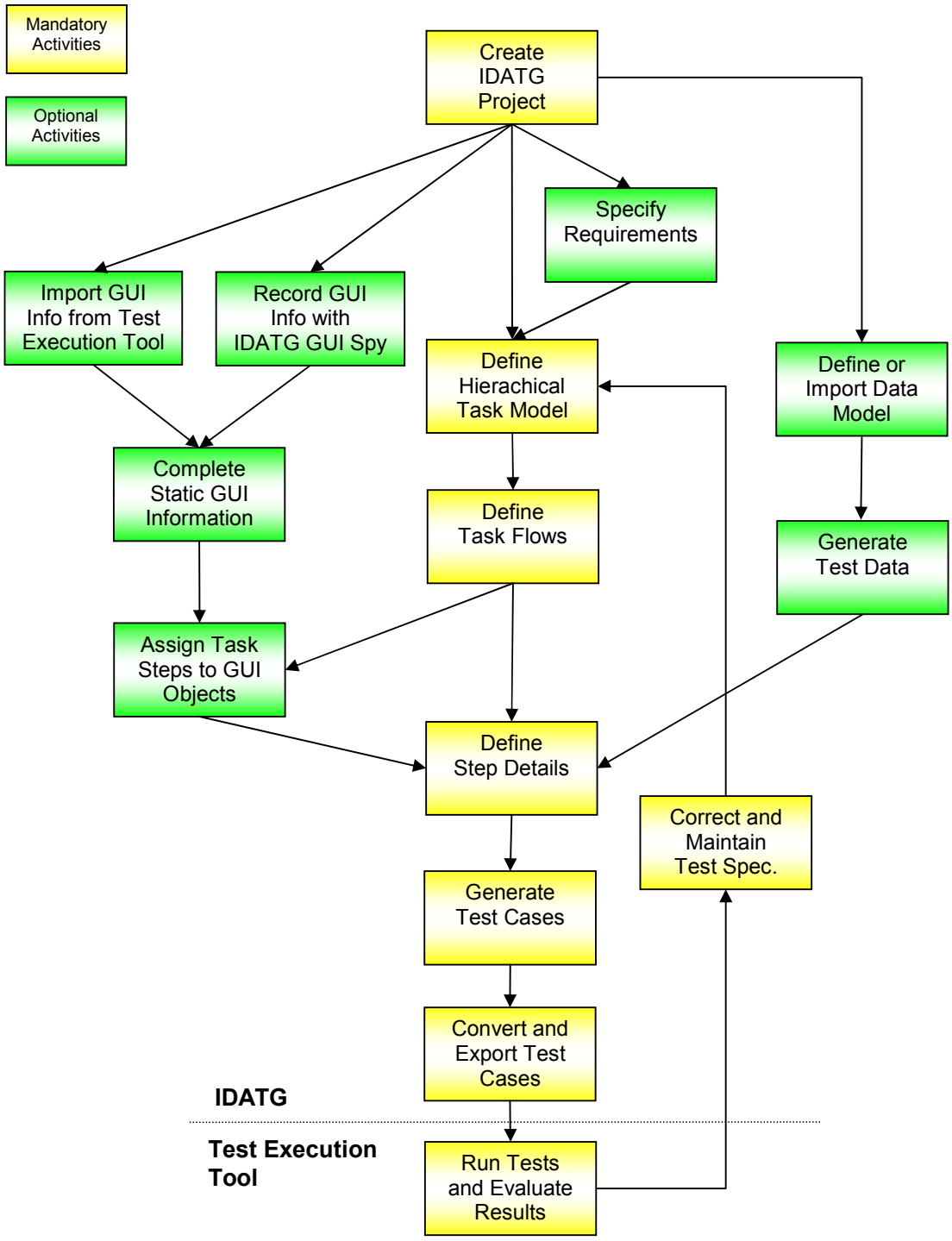


Figure 1 – Test Process using IDATG

1. A **new IDATG project** is created.

2. The required functions of the application can be described in textual form inside IDATG. Alternatively, it is also possible to link to an external **requirements** specification.

3. Based on the textual requirements and the desired test types, a hierarchical **task model** is defined in IDATG. Large tasks are split into re-usable building blocks.

4. For each task, the sequence of steps is defined as a **task flow**. Steps can either be atomic or represent a building block.

5. **Test data** can be imported from a file or be defined manually. However, the most effective way is to use IDATG's state-of-the-art data generation algorithms.

6. As soon as a GUI prototype is available, you can **record GUI information** with the IDATG GUI Spy directly from the screen which saves a large amount of the specification effort.
   Alternatively, you can also **import GUI information** from a test execution tool like HP QuickTest. This method is particularly useful for GUIs not supported by the IDATG GUI Spy.

7. The imported **static GUI information** is checked and where necessary **completed** by altering the names and tags of GUI objects.

8. The **steps** of the task flows can be **assigned to** specific **GUI objects**.

9. The **details of each step** are defined. These include e.g. the test instruction, semantic conditions and the test data.

10. Based on the specification created in the previous steps, IDATG is able to **generate** graph-oriented and data-oriented **test cases**.

11. All **test cases** can be **converted** into various formats and are exported.

12. The **test cases** are executed by an appropriate tool. For GUI testing, IDATG supports QuickTest (HP), WinRunner (HP), Ranorex Studio, SilkTest (MicroFocus), and TestPartner (MicroFocus). These tools start the application, simulate user actions like mouse clicks according to the generated test scripts and check whether the actual results match the expected ones.
    The **test report** produced by the test execution tool has to be **evaluated** by the tester. In case of an error, the tester has to determine its origin (implementation error, specification error, test execution problem...). Appropriate steps have to be taken to fix the problem.

13. If changes or expansions are made to the tested application, it is very important to **update** the specification and task model accordingly. Instead of maintaining the test cases manually, a set of new test cases can be generated very effectively with IDATG.

3 Installation and Startup

3.1 System requirements

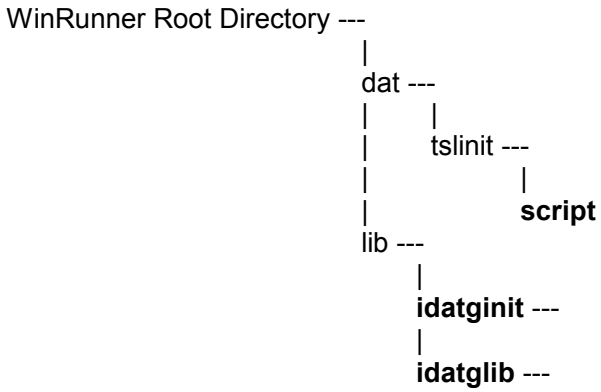
• Hardware:	Pentium PC, min. 1 GHz recommended, 32 or 64 bit
• Operating system:	Windows 98/NT/2000/XP/Vista/7
• Free memory space required:	256 MB
• Additional software required for GUI testing:	HP QuickTest Professional **OR** HP WinRunner **OR** MicroFocus TestPartner **OR** MicroFocus SilkTest (only 4Test-based versions) **OR** Ranorex Studio

3.2 Installation instructions

1. Make sure you are logged in with administrator rights before installing new software.
2. Run the self-extracting file *Setup.exe* that installs the IDATG files to your harddisk and creates shortcuts in the start menu. On some operating systems (e.g., Windows 7), you have to explicitly start *Setup.exe* with administrator rights. If you're asked whether the program should be allowed to modify your system's configuration, answer 'Yes'.
3. Only if you want to run your tests with HP´s WinRunner, you have to perform the following steps before the test scripts can be executed:

   3.1. Install WinRunner (please refer to the WinRunner documentation for instructions)
   3.2. Move the directories *idatginit* and *idatglib* that can be found in your *Idatg\WinRunnerAddIn* directory into the *lib* directory of WinRunner.
   3.3. Open the file *script* in the *dat\tslinit* directory of WinRunner with a text editor and insert the following line directly after the *set_class_map* commands:

```
call "idatginit" ();
```



3.3 License Installation

Before you are able to use IDATG, you need a valid license for your computer. The license is PC-specific and usually restricted to a certain version of IDATG and a limited period of time.

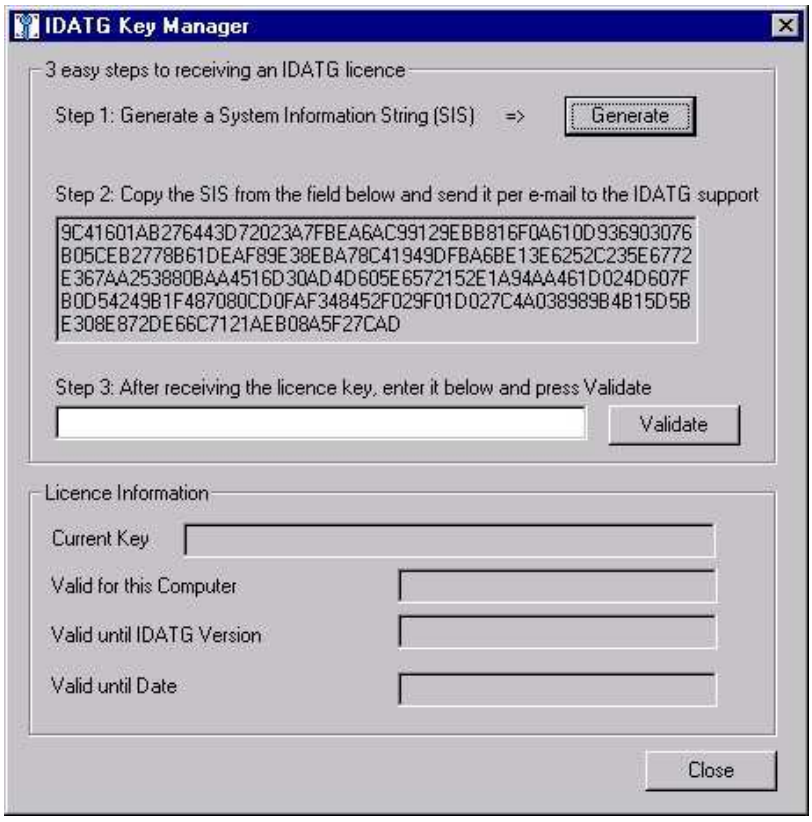

IDATG Key Manager
3 easy steps to receiving an IDATG licence
Step 1: Generate a System Information String (SIS) =>
Generate
Step 2: Copy the SIS from the field below and send it per e-mail to the IDATG support
9C41601AB276443D72023A7FBEA6AC99129EBB816F0A610D936903076
B05CEB2778B61DEAF89E38EBA78C41949DFBA6BE13E6252C235E6772
E367AA253880BAA4516D30AD4D605E6572152E1A94AA461D024D607F
B0D54249B1F487080CD0FAF348452F029F01D027C4A038989B4B15D5B
E308E872DE66C7121AEB08A5F27CAD
Step 3: After receiving the licence key, enter it below and press Validate
Validate
Licence Information
Current Key
Valid for this Computer
Valid until IDATG Version
Valid until Date
Close

Figure 2 - Key Manager

To receive a license, just follow 3 simple steps:

- Make sure you are logged in with administrator rights before installing the license.
- Start the Key Manager. On some operating systems (e.g., Windows 7), you have to explicitly start *KeyManager.exe* with administrator rights. If you're asked whether the program should be allowed to modify your system's configuration, answer 'Yes'.
- Step 1 - Press '**Generate**'. A string will be generated that contains encoded information identifying your PC. This string is called System Information String (SIS).
- Step 2 - Copy the string into an e-mail and send it to the IDATG support. (Just select the string with the mouse, press Ctrl+C to copy it and Ctrl+V to paste it into your e-mail).
- Step 3 - You will receive a reply e-mail containing your license key. Copy the key into the Key Manager and press '**Validate**'. After confirming an information message your license will be installed.

If you wish to use IDATG on different PCs, please run the Key Manager on each of them to generate an individual SIS for each computer.

You can start the Key Manager at any time to view information about the installed license or to install a new one. If you should experience problems with your license or you need an update, do not hesitate to contact the support.

3.4 Startup

You can start IDATG by executing *IDATG.EXE* or clicking on the IDATG icon in your start menu. The following command line parameters can be specified (particularly useful for the integration with a test management tool):

-c	Automatically convert all test cases of the project using the last settings. May only be used in combination with the -p option.
-d name=value	Set the value of a designator. May only be used in combination with the -p option. *name* must be the name of an existing global attribute and has to be written without '#' characters. The -d option can be used more than once in a command line.
-e exepath	The path to the tested application's executable file or for web testing the URL of the tested page. (used for test case conversion)
-g	Automatically generates test cases for the whole project using the test method specified with the -m option (default: step coverage). May only be used in combination with the -p option.
-k keyboard	Set the keyboard type. This option is only relevant to converting test scripts into WinRunner format. Possible values are **us** for US-American keyboards or **ge** for German keyboards.
-m method	Choose the method for test case generation. Possible values are: **G1** (1 graph-oriented test case), **GS** (cover all steps), **GC** (cover all connections), **DV** (cover valid data records), **DI** (cover invalid data records), **DA** (cover all data records), **R** (random test), **T** (transition test). Does only make sense in combination with the -g option.
-p projectpath	The project file specified by *projectpath* is opened automatically. Please specify the complete path to the project's main XML file e.g., "*C:\Program Files\Idatg\Project_MyProject.xml*"
-port portnumber	May only be used in combination with the –sitemppo option. Over this port TEMPPO Test Manager and IDATG communicate via a socket. Default port: 60666
-q	Automatically quit IDATG after performing the other command line options (provided that no error occurred). May only be used in combination with the -p option.
-r rootpath	The directory *rootpath* is used as a prefix for the path to the tested application's executable file and working directory. (used for test case conversion)
-s scriptpath	The generated test scripts are saved to the directory *scriptpath*. (used for test case conversion)
-sitemppo	IDATG is called from TEMPPO Test Manager. TEMPPO Test Manager and IDATG communicate via a socket connection. The port number for the socket must be defined by the –port option.
-w startwindow	Set the window with the ID *startwindow* as start window of the project. May only be used in combination with the -p option. The window must exist, be visible and enabled, and must have no parent.

Example:
idatg.exe -p "C:\Idatg\Projects\MyProject.xml" -d MyAtt=newValue -g -m GS -c -s C:\temp\Idatg -q

Automatically opens the project *MyProject*, sets the value of the global attribute *MyAtt* to *newValue*, generates test cases for the project that cover all steps, then converts them into the directory *C:\temp\Idatg* and afterwards closes IDATG.

3.5 De-installation

To uninstall the program you simply have to call the file *UNWISE.EXE*.

4 Graph-Oriented Test

This chapter explains the basic principles of working with IDATG task diagrams.

4.1 Definitions

Originally, the term **Task** was used in IDATG for sequence diagrams that represented the workflow of typical user tasks. Today, these sequence diagrams are used in a more general way and can represent any sequence of steps that is relevant to testing.

We can distinguish 2 types of tasks:

- A sequence diagram depicting a complete test scenario is called **Use Case Task**. During the generation, IDATG starts at the initial step of the use case task and tries to find a valid path to its end.
- Use case tasks usually consist of **Building Block Tasks** that can be re-used and parameterized. Naturally, building blocks can contain other building blocks. In many respects, they can be compared to functions in a programming language.

The **Task Flow** of a task is a directed graph without cycles that represents a sequence of steps. It may have various branches.

A **Step** inside a task flow may either be an **atomic step** containing a single test instruction or represent an entire **building block task**. In the latter case, the step is also called **Sub Task**. It can be compared to a function call in a programming language. In IDATG, atomic steps are displayed light blue, whereas sub tasks are displayed yellow.

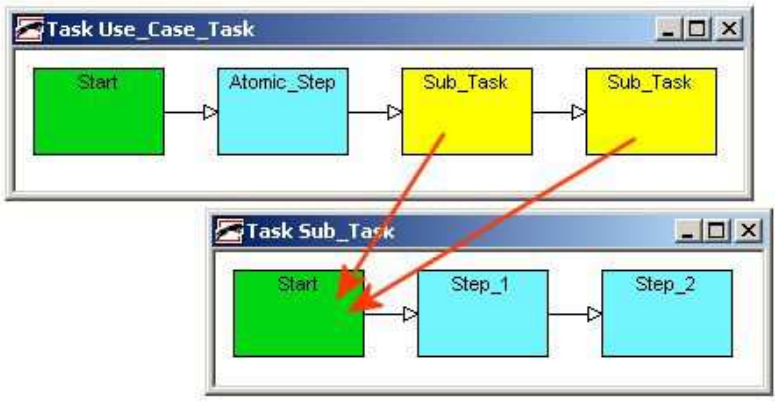


Figure 3 - Atomic Steps and Sub Tasks

A **Connection** between step A and step B means that step B should be executed immediately after step A. Step A is called the **Predecessor** of B and B the **Successor** of A. Each step can have an arbitrary number of predecessors and successors representing different possibilities to perform the task.
A task flow has exactly one **Start Step** (no predecessors) and one or more **Final Steps** (no successors).

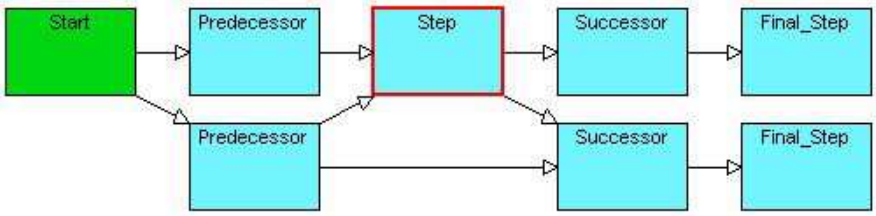


Figure 4 - Task Flow (Example)

Cycles in the task flow are not allowed. However, it is possible to define yellow steps (sub tasks) as **Loops** in which case they are displayed with a double-lined border.
The simplest way is to define the number of times the sub task should be repeated (any number between 1 and 100). However, it is also possible to define loops for data-oriented testing. In this case, the loop is repeated once for each valid and/or invalid record in a data set. In the example below, loops are used to enter 5 persons into a database and to delete all of them afterwards.

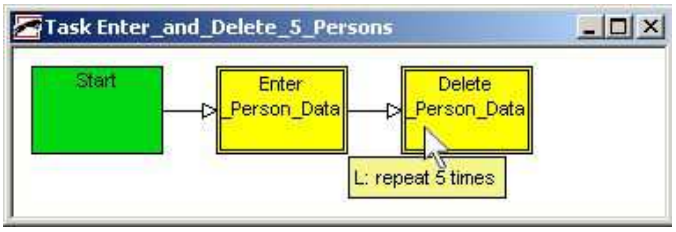


Figure 5 - Task with Loops

A sub task that is used as a loop can contain other loops. However, you should be aware that the length of the resulting test cases as well as the generation time could grow very rapidly if you're not careful. For instance, a loop with 100 repetitions that contains another loop with 80 repetitions results in a test case in which the inner loop is repeated 8000 times!

4.2 General Workflow

The basic workflow for using IDATG has already been outlined in section 2.4 and will now be described in more detail:

4.2.1 Creating a Project

- Start IDATG via the Windows start menu or by executing the file IDATG.EXE.
- Open a new project and select the default GUI builder and output format you wish to use (may be changed later).

4.2.2 Specifying Textual Requirements

You can use the **Requirement Editor** to describe the requirements that should be fulfilled by the tested application. Alternatively, you may only enter the requirement IDs together with the path to an external document.

4.2.3 Defining the Hierarchical Task Model

The basis for specifying the task model is the *software requirements specification* that should exist in every project. It contains a detailed description of all tasks (functions) that the software has to perform *from the user perspective*.

However, IDATG is not limited to only functional test cases. In principle, any test case that can be represented by a sequence of steps can be processed.

- Define the basic structure of the task hierarchy in the **Application Editor** by creating folders and sub-folders that group the tasks e.g. according to the test method or their type (use case / building block). It also might be helpful to use the chapter structure of the software requirements specification as a basis.
- Create a use case task for each item you wish to test and specify its properties using the **Task Properties Editor**.
- Specify which requirements are associated with each use case task using the **Task Requirement Editor**. Later on, this will allow you to keep track of the requirements that are already covered by test cases.

4.2.4 Defining Task Flows

- Define the task flow of each use case task in the **Task Flow Editor** by drawing steps (e.g., Login-DoSomething-Logout). The steps may later on be assigned to windows or building block tasks.
- Instead of drawing frequently used step sequences like "Enter Username - Enter Password - Click Login" again and again for each use case task, it is far more convenient to define them as building block tasks.
- For building block tasks you may want to use the **Task Parameters Editor** to define parameters that can be set to different values every time the task is used. For the building block "Login" the parameters will probably be "Username" and "Password".
- Cycles in the graph are not allowed. However, building block tasks can be defined as **Loops** which means that they can be executed multiple times. Loops can be repeated either a specified number of times or for each record in a data set.
- Note that building block tasks can be further divided into even smaller building blocks. Just remember: Modularization brings clearness and maintainability!

4.2.5 Defining the Step Details

- If you want to use IDATG for GUI testing, please refer to section 8.1 for information on assigning a step to a GUI object.
- For each step in the task flows, you can specify its properties in the **Step Editor**. These include a meaningful name, the test command and its duration (delay).
- In addition, you can define the step's pre-conditions in the **Condition Editor** and its effects in the **Action Editor**. Note that only those actions have to be defined that have an influence on commands or conditions in subsequent steps of the task flow.
- In most fields it is possible to refer to a designator rather than providing a concrete value (e.g. *Input(#@Login:Username#)* instead of *Input("Value")*). During test case generation, all designators will be replaced by their current value.

4.2.6 Generating Test Cases

From the task model the **Test Case Generator** is able to generate test cases that cover all steps and connections of a use-case task. It also detects specification errors like conditions that can never be fulfilled. After the generation, you can open the test cases in the **Test Case Editor**.

4.2.7 Converting Test Cases

Before the generated test cases can be executed, they have to be converted into a tool-specific format.

- Select the desired task or folder and call the **Test Case Converter**. All test cases for the object are converted and written to the selected target directory. If you selected the option "Plain

Text", IDATG exports the test commands without further translation which can be useful e.g. for generating Tcl scripts. For GUI testing, the following files are generated:

- A GUI Map containing a description of all GUI objects
- Test scripts containing the test cases in the tool-specific language
- A main script that calls all other scripts

5 Data-Oriented Test

Apart from test sequences that can be expressed with a graph it is also important to define the input data that should be used for the tests. IDATG provides a number of powerful features for creating this data and for including it in the task flows.

5.1 Creating Test Data

Using the **Application Editor** tab page "Test Data" it is possible to define **data sets** and the **data fields** they consist of. Data fields correspond to columns in a data table. Rows are represented by **data records** that include 1 value for each data field.

IDATG offers the following methods for defining data records:

- Generating test data using the equivalence class method
- Generating test data using CECIL (Cause-Effect Coverage Incorporating Linear boundaries), a powerful combination of the Cause/Effect, Multi-Dimensional Equivalence Class and Boundary Value methods
- Importing test data from an external source
- Specifying test data manually

5.1.1 Generating Test Data Using the Equivalence Class Method

Since it is usually impossible to test a component with every possible input combination, various methods are used to reduce the number of test data while still revealing a high number of program faults. The most common way for finding test data is the equivalence class method.
The definition range of each input variable is partitioned into various equivalence classes according to the following rule: An **equivalence class** or **equivalence partition** is a contiguous value range consisting of values that cause equivalent outputs or for which apply the same calculation rules. Classes containing valid input data are usually named V_n while invalid classes are named I_n.

Procedure:

1. Determine definition ranges per variable
2. Refine equivalence classes for each variable
3. Implement positive test cases
   Create data records by taking 1 representative value from a valid equivalence class of each variable. Repeat until all valid classes are covered.
4. Implement negative test cases
   Create data records by taking 1 representative value from an invalid equivalence class and all other values from valid equivalence classes until all classes are covered. Combining 2 or more invalid values in a record is not allowed because the values' effects may cancel each other out. Repeat until all invalid classes are covered.

Example:

```
int MyFunc(int a, int b)
{
      if (a<0) return -1; // error
      else if (a<20) return sqrt(a); // square root(a)
      else return a / b;
}
```

Step 1: The definition range of *a* and *b* is [MININT-MAXINT].

Step 2: The ranges can be further divided into the following equivalence classes:

Class ID	Range	Expected Output
Variable a		
I1_a	[MININT..-1]	-1
V1_a	[0..19]	sqrt(a)
V2_a	[20..MAXINT]	a / b
Variable b		
V1_b	[MININT .. -1]	a / b
I1_b	0	undefined (division by zero)
V2_b	[1 .. MAXINT]	a / b

Step 3: Create valid data records until all valid classes are covered

Record ID	a	b
V1	0	MININT
V2	20	MAXINT

Step 4: Create invalid data records until all invalid classes are covered. Do not combine 2 invalid values.

Record ID	a	b
I1	MININT	MININT
I2	20	0

IDATG provides a convenient **Equivalence Class Editor** that allows you to define classes and representative values for each data field. After this information has been entered for each data field in a set, IDATG's **Test Data Generator** can automatically create a set of data records that fulfill specified test coverage criteria.

5.1.1.1 Boundary Value Analysis

The boundary value analysis is an extension of the equivalence class method. It relies on the fact that many programming errors can be detected by concentrating on the boundaries of each equivalence class (e.g. writing *i<0* instead of *i<=0*). Boundary values can be entered in the **Equivalence Class Editor** and are considered during record generation if the corresponding option is chosen.

5.1.2 Generating Test Data Using CECIL

The previous example has shown how the simple EC method can help to find effective test data for a set of independent input variables. Unfortunately, in many cases this simple method cannot be applied, because the input variables are not independent of one another. For instance, a triangle can only be constructed of three sides where each sum over two sides must be greater than the third.
In such cases, we are dealing with multi-dimensional ECs. The number of "dimensions" depends on the number of interdependent input variables. IDATG is the only tool that can deal with such complex specifications in a satisfying way by using its unique CECIL method. (Cause-Effect Coverage Incorporating Linear boundaries)

5.1.2.1 Vehicle Insurance Example

The IDATG package includes a detailed example which illustrates the usage of the CECIL method. It consists of an IDATG project "*Projects\Project_Insurance.xml*" and an application "*\bin\Insurance.exe*".

Problem Description
We want to test an application that calculates the annual insurance premium for a vehicle (Motorcycle, Car, or Van).

The basic premium depends on the engine power (in HP) and the vehicle type:

	Motorcycle
< 25 HP	50 €
25 - 49 HP	75 €
>= 50 HP	100 €

	Car	Van
< 60 HP	100 €	200 €
60 - 99 HP	200 €	400 €
>= 100 HP	300 €	600 €

For person groups with a higher accident risk, the premium is 20% higher. These groups are: all persons older than 65 years, men younger than 25, and women younger than 21.

Only persons aged between 21 and 65 are allowed to drive a van. To drive a car or motorcycle, a person must be at least 18.

Problem Analysis
In this example, we have 4 input variables: the vehicle **Type**, the **HP**, the **Age**, and the **Gender**. We note that there are 3 distinct types of effects that all affect the end result (= the insurance premium):

- The **Baseprice** which depends on the Type and the HP
- The **Extracharge** which depends on the Age and the Gender
- **Invalid** combinations that depend on the Age and the Type.

Baseprice and Extracharge are provisional results required for calculating the final end result and are called **Effect Variables** in CECIL.

Step 1: Define Data Structure
Using the **Data Set Editor** and **Data Field Editor**, it is very easy to define the 4 input variables and their ranges. Since the CECIL method involves a mathematical algorithm, only numeric input variables can be used. However, it is quite easy to represent enum types as numbers (0=Motorcycle,1=Car, 2=Van; 0=Male, 1=Female).

Step 2: Define Causes and Effects
Next we have to express the textual description as formal conditions. In IDATG this can conveniently be done in the **Data Effects Editor**. It allows the user to define cause/effect pairs plus the effect variables they affect.

Effect-ID	Condition (Cause)	Effect
SMALL_BIKE	Type = 0 AND HP < 25	baseprice = 50 €
MEDIUM_BIKE	Type = 0 AND HP >= 25 AND HP < 50	baseprice = 75 €
BIG_BIKE	Type = 0 AND HP >= 50	baseprice = 100 €
SMALL_CAR	Type = 1 AND HP < 60	baseprice = 100 €
MEDIUM_CAR	Type = 1 AND HP >= 60 AND HP < 100	baseprice = 200 €
BIG_CAR	Type = 1 AND HP >= 100	baseprice = 300 €
SMALL_VAN	Type = 2 AND HP < 60	baseprice = 200 €
MEDIUM_VAN	Type = 2 AND HP >= 60 AND HP < 100	baseprice = 400 €
BIG_VAN	Type = 2 AND HP >= 100	baseprice = 600 €
OLD_PERSON	Age > 65	extracharge = 20%
YOUNG_MALE	Gender = 0 AND Age < 25	extracharge = 20%
YOUNG_FEMALE	Gender = 1 AND Age < 21	extracharge = 20%
NORMAL_MALE	Gender = 0 AND Age >= 25 AND Age <= 65	extracharge = 0%
NORMAL_FEMALE	Gender = 1 AND Age >= 21 AND Age <= 65	extracharge = 0%
I_TOO_YOUNG	Age < 18	Invalid
I_VAN_TOO_YOUNG	Type = 2 AND Age < 21	Invalid
I_VAN_TOO_OLD	Type = 2 AND Age > 65	Invalid

Table 1 - Causes and Effects for the Vehicle Insurance example

- All conditions that affect the same effect variable should be mutually exclusive. For instance, "*Age > 65*" and "*Age < 70*" would have overlapping value ranges.
- It is not necessary to include the definition ranges of the input variables in the conditions (this has already been done in the **Data Field Editor**). For instance, OLD_PERSON: "*Age > 65*" automatically assumes "*Age < 999*".
- It is not necessary to explicitly exclude invalid cases - this is done automatically. For instance, SMALL_BIKE: "*Type = 0 AND HP < 25*" automatically assumes that I_TOO_YOUNG: "*Age < 18*" is not true at the same moment.
- It is possible to refer to effects that have already been defined using the format *%EffectName*. For instance, you may write *#Age# > 65 AND NOT (%MEDIUM_BIKE)*.
- All conditions must be **linear** in nature. This means that it must be possible to transform them into the form "*a*var1 + b*var2 + … < n*" where a,b,.. n are constant numbers. In particular, it is not allowed to multiply or divide two variables (*5 * Age < HP* is allowed, *HP * Age < 5* is not).

Step 3: Generate Data Records
After the effects have been defined, IDATG's **Test Data Generator** can automatically create a set of data records that covers all effects and their multi-dimensional boundaries.

The basic algorithm works like this:
- Choose 1 effect for each effect variable (e.g., *SMALL_BIKE* for the variable *baseprice* and *OLD_PERSON* for the variable *extracharge*).
- Combine the conditions of these effects (e.g., *Type = 0 AND HP < 25 AND Age > 65*). Mathematically speaking, the conditions define a multi-dimensional space which can be seen as a multi-dimensional equivalence class.
- Search the boundaries of this space by using a sophisticated linear programming algorithm. Try to find the minimum and maximum value in the space for each variable. (for this example, the solution is trivial, but the algorithm can also handle complex conditions)

- To reduce the number of test data, discard boundaries that include no unique variable values (e.g., *(0,0,66,0), (24,0,66,0), (0,0,999,0), (24,0,999,1)* can be reduced to (0,0,66,0), (24,0,999,1) without losing any unique values).

In order to avoid defect masking, 2 invalid effects may not be combined. Instead, 1 invalid effect is taken and combined only with valid effects (this is only possible if the conditions do not contradict each other).

5.1.3 Importing Test Data

Another easy way for getting test data is importing it from an external file. Each row in the file is added to the *Records* folder of the data set. It is assumed that all imported data records contain valid data. IDATG supports e.g. tab-separated files or .csv files. In case of a new data set, data fields are automatically created and named after the column names in the header line.
In case of an existing dataset, it is checked whether its data fields correspond to the columns in the file. If not, an error message appears and the user has to update the data field structure before continuing.

5.1.4 Specifying Test Data Manually

It is also possible to define data records manually using the **Data Records Editor**. This method requires the most effort, but can be helpful to test special data combinations that cannot be covered by the generator.

5.2 Creating Data-Based Task Flows

Regardless whether the test data has been generated, imported or specified manually, it is necessary to create a connection between the data and the task flow. In particular, it has to be specified in which steps the data is used.
It is also important to decide whether a separate test case should be generated for each data record or if more than one record should be used in one test case.

5.2.1 Basics

- **Drawing data-oriented task flows**
  We recommend to divide a data-oriented use case task in at least 2 building blocks: An *Input* block for entering the data and a *Verify* block that checks the results. Typically, the *Verify* block will contain a conditional branch for each possible program reaction (in other words, for each equivalence class of the input data). The *Demo* project included in the IDATG setup illustrates the basic concept.

- **Creating references to test data in steps**
  The value of a data field in the current record can be referenced using the following designator syntax:

  #~DataSet:DataField#

  For instance, *#~Person:Age#* refers to the value of the field *Age* in the current record of the data set *Person*. Like all other designators data references can be used in step events, commands, conditions etc.

  Data sets also have two pre-defined designators that refer to properties of the current data record: *#~DataSet:$id#* and *#~DataSet:$valid#*.

Typically, the *Input* building block will contain step events like *Input(#~Person:Age#)*, while the branches in the *Verify* block will have conditions like *#~Person:$valid# AND #~Person:Age# > 18*.

If you used the CECIL method for generating test data, you can even include references to the effects (*#~DataSet:~EffectName#*) and effect variables (*#~DataSet:@VarName#*):

- The *Verify_Error* block in the Insurance example contains conditions like *#~Insurance:~I_TOO_YOUNG#* that distinguish the different kinds of invalid data.
- In addition, the step *Verify_Premium* has an event that actually calculates the correct premium (!):
  *Verify(VALUE, (#~Insurance:@baseprice# * (100 + #~Insurance:@extracharge#)) / 100)*

5.2.2 Generating 1 Separate Test Case for each Data Record

- **Assigning a task to a data set**
  The first step is to assign a use case task to a specific data set. After selecting a data set in the **Task Properties Editor**, the task icon includes a small data symbol that makes it distinguishable from normal use case tasks. When generating test cases, IDATG will try to create a test case for each record of the selected data set.

- **Generating Test Cases for each Data Record**
  After a data-oriented task has been defined, it is possible to generate test cases for it. Just select the task, open the **Test Case Generator** and check the option "Data-oriented Test". You can also select whether you want to cover all valid and/or all invalid records of the data set assigned to the task.
  IDATG will generate 1 test case for each record (provided that all records satisfy at least 1 condition in the *Verify* block). All designators inside the task flows - including the references to test data - will be replaced by the current designator values.

5.2.3 Using more than 1 Data Record in the same Test Case

- **Defining Data-oriented Loops**
  The **Sub Task Editor** provides the possibility to define entire sub tasks as loops. If a loop is assigned to a data set, it is repeated for each valid and/or invalid data record in this set. If you define an *Input* and a *Verify* building block as shown in "Drawing data-oriented task flows" above and combine these 2 blocks into a loop, it is e.g. possible to fill an entire data base in one single test case.

- **Changing the Data Record Pointer Manually**
  It is possible to manipulate the generator's internal pointer that defines the currently selected record of a data set. The following Actions can be used for this purpose:

Action Name	**Arguments**	**Description / Example :**
GotoDataRecord	*Dataset (DataSetName)* *RecordID (String)*	Move the record pointer of the data set to the selected record. e.g. *GotoDataRecord(#~Person#, "v01")*
NextDataRecord	*Dataset (DataSetName)* *RecordType (V, I, or A)*	Move the record pointer of the data set to the next record of the selected type (V=Valid, I=Invalid, A=All). If there are no more records, the pointer is reset to the first one. e.g. *NextDataRecord(#~Person#, v)*

ResetDataRecord	*Dataset (DataSetName)* *RecordType (V, I, or A)*	Reset the record pointer of the data set to the first record of the selected type (V=Valid, I=Invalid, A=All). e.g. *ResetDataRecord(#~Person#, i)*

- **Generating Test Cases**
  In the **Test Case Generator** do NOT check the option "Data-oriented Test" but select "Graph-oriented Test" instead. "Data-oriented Test" should only be used if you want to generate 1 test case per record.

6 Random Test

6.1 Introduction

The term **random testing** in general describes the process of selecting inputs for software under test (SUT) from a given set of inputs at random. For this purpose some model of the software is needed. In IDATG the model is represented as a set of building blocks.

As for normal graph-oriented testing, the basis for random testing is a task flow model of the software under test and its specification. However, for random testing no use case tasks are required so that the model consists only of building blocks. The random test case generation tries to find a path through these blocks. That is, it tries to start at one step in the beginning of a building block and then find a sequence of steps that lead out of this first building block. After that is done, the algorithm tries again to enter a building block (which may be the same as the first one). This goes on until all defined exit criteria are fulfilled.

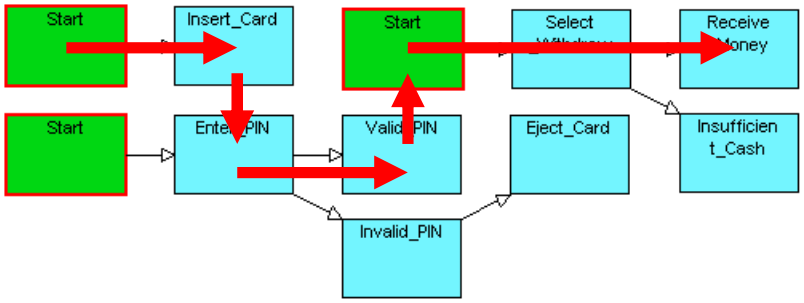


Figure 6 - IDATG Model with three Building Blocks and a walk through them (in red)

In Figure 6 you can see an illustration of a simple IDATG model. It consists of three building blocks (each of them beginning with a green start step). The random test case generation generated a random walk through them. This walk is marked with red arrows for illustration here. In IDATG you can see your generated random test case as usual. This example shows a simple automated teller machine, which starts with inserting a card, then entering a pin and then withdrawing some money. In this example one can see that several steps, such as “Insert_Card” were covered by the test case shown by the red arrows, whereas other steps such as “Eject_Card” were not covered.

6.2 IDATG Task Structure for Random Testing

As was mentioned above, random testing only uses building blocks, but no use case tasks. The building blocks that should be combined randomly have to be located in the same folder. This main folder may have subfolders. All building blocks in this folder or one of its subfolders will be used for random testing. Building blocks not inside the main folder will be ignored. In Figure 7 the recommended folder structure is shown. The folder “RandomTesting” is the main folder for random testing and contains two building blocks that will be used to create the IDATG model of the software under test. The building block in “AuxiliaryFolder” and the building block “NotUsed2” will not be used. Likewise, the use case task in the “RandomTesting” folder will be ignored.

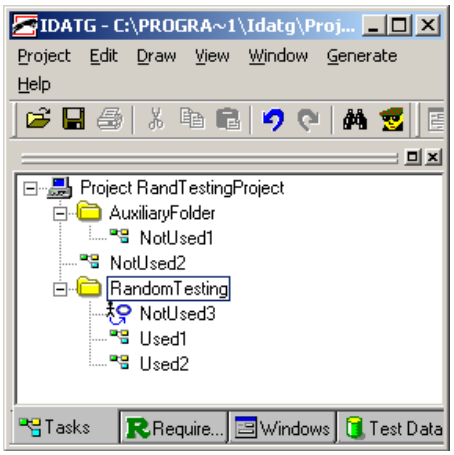


Figure 7 - IDATG Folder Structure for Random Testing

It may be convenient to use building blocks in random testing that have sub-building blocks. In the case that these sub-building blocks should not be used as “stand-alone” building blocks, one can just put them in a different folder than the “RandomTesting” folder. This is shown in Figure 7 with the folder “AuxiliaryFolder”. The building block “NotUsed1” may be used as a sub-building block in “Used1” or “Used2”, but it will never be used alone in the random test case generation.

If in the example above the project is selected as the main folder, all building blocks inside it are used (all in the example).

No special properties have to be set for a folder to use it for random testing. It is sufficient to select the desired folder before starting the test case generation.

6.3 IDATG Building Block Structure for Random Testing

This chapter describes the requirements for building blocks used for random testing. It is useful to view a generated random test case as a walk that goes through several building blocks.

6.3.1 Building Block Requirements

In general, two requirements for building blocks exist:

1. Building blocks shall not contain dead ends
2. The pre-conditions for performing a certain step in the real system under test have to be specified very thoroughly in the IDATG model. It must not be possible that a step sequence is generated that is impossible in the real system.

The first requirement states that it should always be possible to reach an end step (that is a step in the building block without successors) without violating any conditions. The reason behind this is, that when the random test case generation enters a building block and cannot leave it, this test case must be closed and cannot be extended any further (in this case a warning will be displayed for the user).
This requirement can be dropped, in theory, if the tester explicitly creates steps that end the testing process. An example for a building block with a dead end is shown in Figure 8.

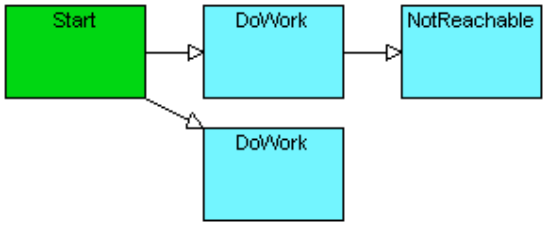


Figure 8 - Building Block with dead end

The second requirement is that no invalid test cases can be generated. Consider for example a step that clicks on a button “Delete”, then this button must be clickable when the test case reaches this step. Therefore at some point there must be a condition that ensures that this button is enabled.

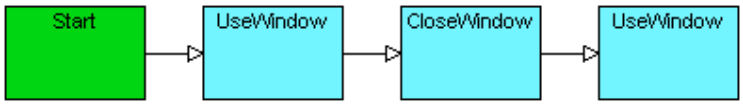


Figure 9 - Building Block with incorrect reachable step

In Figure 9 you can see an incorrect building block. Assume that none of the steps has conditions. Then, after the window is closed, the last step tries to use the already closed window. This should not be possible.

You can also specify conditions at the beginning of a building block that define the requirements that must hold for several paths. An example is shown in Figure 10.

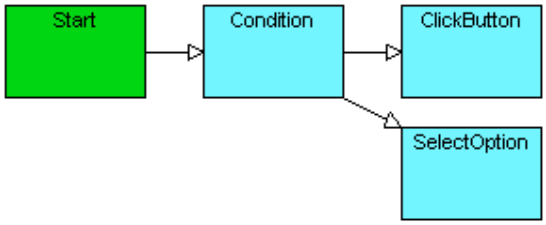


Figure 10 - Building Block with condition at the beginning

6.3.2 Describing Window Behavior

A detailed specification of the GUI behavior is required for random testing with IDATG (unless of course the system under test has no GUI).

Whenever an event opens or closes a window, the action of that step should be set accordingly with “OpenWindow” or “CloseWindow”.

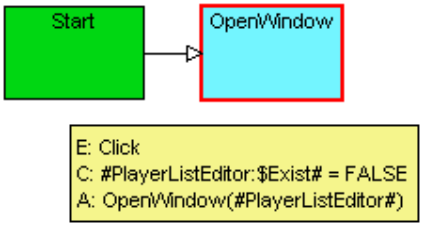


Figure 11 - Building Block with OpenWindow action

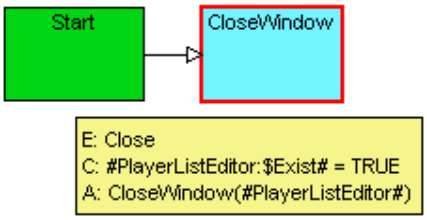


Figure 12 - Building Block with CloseWindow action

Figure 11 shows an example where a window (here called “PlayerListEditor”) is opened. The fact that the window remains open after the step is specified by an action. The yellow box shows some details of the step. In this case the step has the condition that requires the window to be not open. This is generally not required, since in some cases you may open an already existing window. Figure 12 shows an example for a CloseWindow action, with the pre-condition that the window to be closed must exist (see below for an alternative).

Specifying the condition of a step using certain GUI elements can be done in two ways:

1. Entering the window as “Start Window” in the **Step Editor**.
2. Defining a condition that the window exists.

The first choice is usually preferred, since it is required anyway if a step manipulates a window. The second one may be needed if a step without events is used and has conditions for other successor steps. This means that in the example in Figure 12 the condition may be dropped, since the “CloseWindow” action already has a specified window in the Start Window section and therefore already knows that this window must be usable.

Open/Close actions may not be enough. In some cases opening or closing a window may, for example, “reset” certain values. This additional behavior must be captured, too, if other steps rely on those values. An example is shown in Figure 13. Here a complete test case was generated by using several building blocks. The outcome is that first some element is selected. After that the window where the element was selected is closed and reopened. The behavior of the tested system is that the selection is reset to a default value thus invalidating the previous selection. In this case, the reset of the selection should be modeled as action in either the “CloseWindow” or “OpenWindow” step.

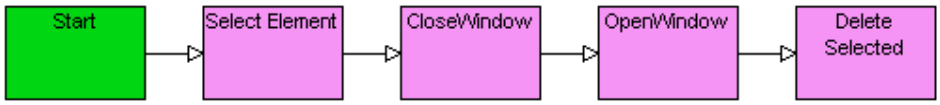


Figure 13 - Invalidation by reset

Lastly, sometimes it may be convenient to use the action “OpenModalDlg” instead of “OpenWindow”. The difference is that if a modal dialog is opened, then only this window and its children are usable, all others are inactive. One should not forget to close such modal dialogs as usual with “CloseWindow”.

6.3.3 Using Test Data

If you want the random test case to choose entries from a test data set randomly, simply add a building block containing the action “NextDataSet” and no condition. This block will be built into the generated test cases an arbitrary number of times, thus ensuring that not always the same data record is used.

6.4 Test Case Generation

The user workflow for random testing is as follows:

1. Select the folder containing the building blocks for random testing (this may be the project folder itself)
2. Select “Generate Test Cases” from the menu or via the toolbar.
3. In the **Test Case Generation Dialog**, choose “Random Test” and press "Random Test Options…"
4. Choose the **Random Test Options** (see below)
5. Start the test case generation with “OK”.

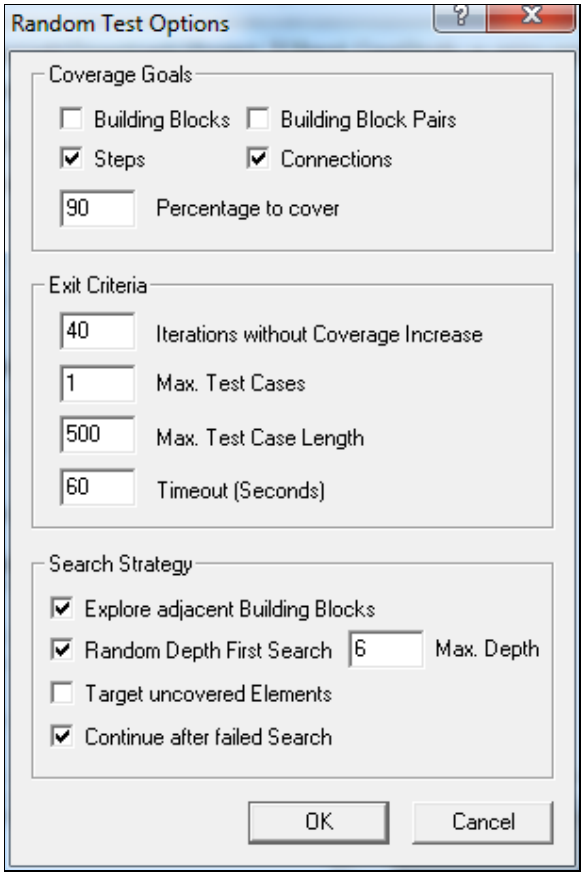


Figure 14: Parameters for random testing (with default values)

6.4.1 Random Test Options

6.4.1.1 Coverage Goals

Here you can specify what the random test case generator should cover.

Building Blocks is the simplest coverage goal, which just says that the algorithm should try to enter each block at least once, but not necessarily exhaustively cover each block.

Steps & Connections is the default coverage goal which tells the algorithm to cover all steps and connections at least once.

Building Block Pairs is the most difficult coverage goal to fully achieve. Its meaning is that all pairs of building blocks should exist in the final test case in direct succession. This means for example for the blocks 1 and 2 that the algorithm should try to create a test case where 1-1, 1-2, 2-1 and 2-2 are contained. Please note that in general this is impossible due to conditions. Assume that block 1 opens a window and block 2 closes it, then 2-2 may not be possible.

Percentage to cover signifies how much of the chosen coverage goal should be covered by the algorithm. If the chosen coverage is reached, the process stops. Usually 90-100 percent is chosen, but for some cases (unreachable steps in the model) a lower percentage might be better suited.

Recommendation: Steps and Connections

6.4.1.2 Exit Criteria

Here one can specify the number of test cases and their length.

Iterations without coverage increase is an important parameter for random testing. Simply put it is the amount of “freedom” the random generator has. The lower the value, the more deterministic the result will be. Its precise meaning is how many steps the algorithm may add randomly to a test case even if they do not contribute to a coverage goal. If this number is reached, then the algorithm switches to a search strategy. Note that if no search strategy was chosen, then this parameter is meaningless. If there are very large building blocks in the model with many steps in a sequence, one should increase this parameter.

Max Test Cases is the number of test cases to generate. If the chosen coverage goal is reached before this number of test cases is created, then the algorithm stops.

Max Test Case Length the maximum number of steps in a single test case. One should not set this value too low, since a random test case generator needs more tries than a purely deterministic one. A rough guideline is to use the number of steps in the model multiplicated by a factor of 3-8. The factor should be set higher if the model is more complex (uses many conditions, has many different paths in each block) and lower if the model is simple.

Timeout is the timeout in seconds.

Recommendation: 1 Test case, Test case length approx: (number of steps in model x 5), Iterations without coverage increase: 50.

6.4.1.3 Search Strategy

Here one can choose the search strategy to be applied in case the random generator fails to reach any uncovered elements in the model.

Random Depth First Search searches exhaustively within a certain bound. This usually improves the coverage by a reasonable amount. Medium running time.

Exploration of adjacent Building Blocks Simple strategy, which explores blocks exhaustively with often good results. Short running time in general.

Construct Path to uncovered Element Sophisticated strategy, which searches for uncovered elements and tries to construct a path. Has a long running time. Should only be used in conjunction with both other strategies.

Continue after failed search Defines whether the random generator should continue if the search fails.

Recommendation: Disable only "Construct Path to uncovered Element" due to its long running time. For very simple models one may disable all search strategies.

6.4.1.4 Tips & Tricks for Random Test Options

Problem	**Suggestion**
Low coverage (general tips)	Increase Max Test Case Length Increase Max Test Cases Enable more Search Strategies Increase Search Strategy Depth Look for unreachable steps by checking step conditions
Low coverage in a large model	Increase Iterations without Coverage Increase
Low coverage in a small model with complex conditions	Decrease Iterations without Coverage Increase
Too short test cases	Disable Search Strategies

7 Transition Test

Apart from defining entire test sequences with task flow graphs it is also possible to specify a set of individual state transitions. Based on the pre-conditions and effects (actions) that have been defined for each transition, IDATG is able to generate a valid sequence automatically. The highly complex generation algorithm has even been patented.
The first versions of IDATG supported only the transition test method. However, while the generation algorithm is very powerful, it requires a certain skill level for the user to create an appropriate specification. Also, it can only be used for GUI testing, but not for API testing. Today, in most projects the graph-based task flow method is sufficient. Nevertheless, the traditional transition test method is still supported. Many steps in the workflow are the same as for graph-based testing, therefore only the differences have been described in detail:

7.1 Workflow

In order to obtain a consistent GUI specification we recommend the following procedure:

7.1.1 Defining the GUI Behavior

- Record the GUI layout with the GUI Spy and complete the static GUI information as described in section 8.1.
- Define the start window of the application, i.e. the window that you see when you start the application. This window must not have a parent and must be visible and enabled. You can select the start window in the **Application Editor**.
- Specify, how the application can be terminated. Just draw a transition from the object that closes your application (e.g., an 'Exit' button) back to the same object and associate it with the action ‚CloseApplication'. If you do not have a trigger window like an 'Exit' button, you can also specify a transition that is triggered by a key combination. Most applications can be terminated by pressing <Esc>, <Alt-x> or similar key combinations.
- Specify how windows can be opened and closed by drawing transitions associated with ‚OpenWindow' and ‚CloseWindow' actions. Dialogs should be opened with ‚OpenModalDialog', if the user cannot use other windows while the dialog is open. Three requirements must be fulfilled before a test case can be generated for a window:
  1. It must be existing. This is true, if the window is opened explicitly with ‚OpenWindow' or if its parent window is existing and the openMethod is set to ‚Parent'. (Which signifies that if the parent exists, the window is also existing).
  2. It must be visible. This is true, if the window is opened explicitly with ‚OpenWindow' or if the attribute #*WindowID*:$Visible# is set to true. Note: If the parent is invisible, the child is also invisible, but if the parent is visible, the child is not necessarily visible!
  3. It must be enabled. This is true, if the window is opened explicitly with ‚OpenWindow' or if the attribute #*WindowID*:$Enabled# is set to true. Note: If the parent is disabled, the child is also disabled, but if the parent is enabled, the child is not necessarily enabled!

- If you do not specify a ‚CloseWindow' action, IDATG assumes that the window remains opened. This may be a problem, if the window is a systemmodal dialogbox. ‚Systemmodal' means that no other windows can be used while this window is open. Be sure to define a ‚CloseWindow' action for all systemmodal dialogboxes to avoid problems during test case generation. ‚CloseWindow' actions are unneccessary in a ‚CloseApplication' transition.
- After you have specified all these basic transitions that simply serve for navigation through the GUI, it may be helpful to let IDATG generate test cases to check, if the specification is consistent up to this point. If a test case could be generated for each transition, we can start to define the semantics of the application.

7.1.2 Specifying the Semantics of the GUI

- Now comes the most challenging part of the GUI specification, the definition of transitions that depend on certain semantic conditions or that have certain semantic effects. Try to keep in mind how IDATG generates test cases: it always searches for possibilities to fulfill the conditions you enter. Conditions that only depend on the contents of GUI objects are trivial to solve, e.g. to fulfill *#Name# != ""*, IDATG knows exactly what to do (enter a value in the field ‚Name'). However, there is no uniform way to solve conditions that depend on other attributes, so you have to make sure that there is a way to solve them. For example, if you entered a condition *# WindowID:CreateMode# = TRUE*, but did not specify how the designator *CreateMode* can be set to true, it is impossible to generate a test case. But if you somewhere defined a transition with the action *SetAttribute(#WindowID:CreateMode#, TRUE)*, a solution can be found.

7.2 Integrity Rules for Transition Diagrams

Before generating transition coverage test cases, please observe the following pre-conditions:

- A start window and at least one end transition (that has the action *CloseApplication*) are defined for the application.
- From the application´s start window it must be possible to reach all other windows that have state transitions. Likewise, it must be possible from all windows to reach an end transition (Don´t forget to close modal dialogs!).
- Note that a transition may only be executed if its start window is opened, enabled and visible and if all its conditions are fulfilled. Of course, the destination window of a transition must also be opened, enabled and visible *after* the transition.
- It must be possible to fulfill all specified conditions either by executing transitions with appropriate actions or by entering values into fields.

7.3 Transition Types

Depending on the hierarchical relationship of the start and destination window, various transition types can be distinguished. A thin arrow from window A to window B signifies that A is the parent of B, a bold arrow with a number represents a transition and its type.

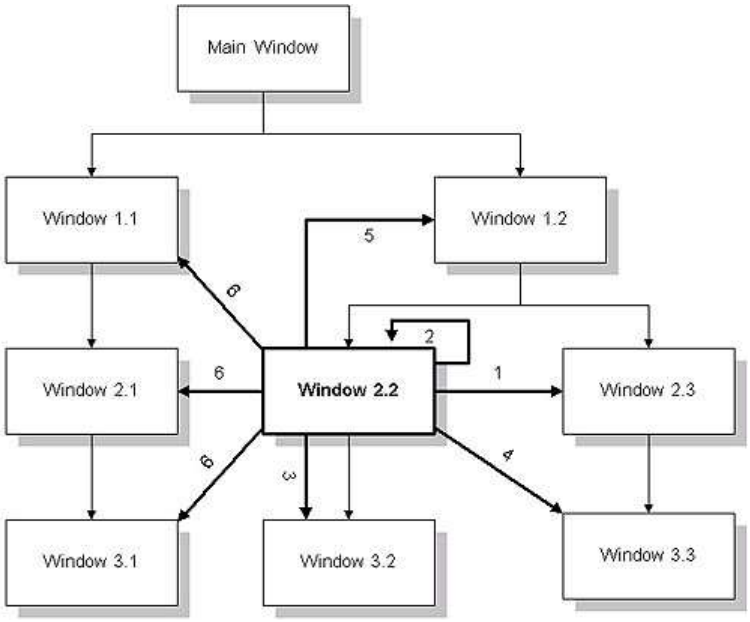
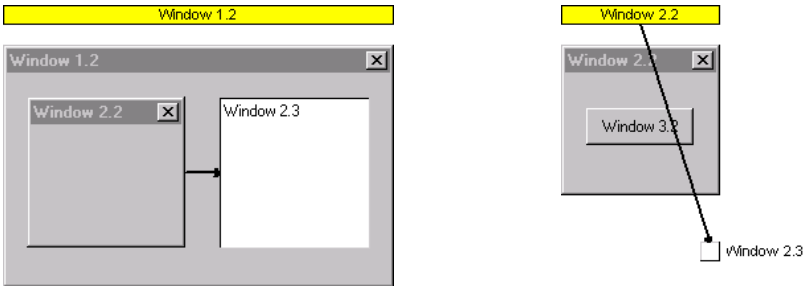


Figure 15 - Overview of Transition Types

Since it is possible to open a **Window Editor** in each of the hierarchy levels, most transitions are displayed in 2 different **Window Editors**. First, in the editor for the parent of the start state, second in the editor for the start state itself. Likewise, there are also 2 possibilities to select a state: Either click on the state in the editor of its parent window or click on the top in the editor of the state itself. For example:

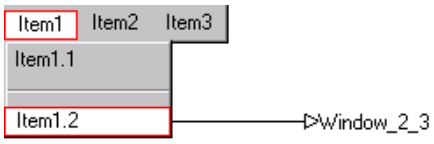
Parent layer: Normal transition arrow.
Start state layer: Transition from the top to a window symbol.



Transitions that are triggered by a menu item

Transitions that are triggered by **menu items** are a special case and can be drawn in the **Menu Editor**

Note: The **menu item** itself is not really a state, it is just the trigger (event) for the transition. Menu items can only be the start state of a transition, but not the destination state.



8 GUI Testing

8.1 Workflow

In addition to the activities described in chapter 4.2, the following steps are required for testing graphical user interfaces:

8.1.1 Recording the GUI Layout

- The IDATG database contains pre-defined information about the most common GUI Builders. If your application uses a different GUI Builder or some self-defined window classes, you can specify them in the **GUI Builder-** and **Window Class Editor**. However, first you have to make sure that your test execution tool is able to recognize these GUI objects correctly. The fact that IDATG recognizes a certain GUI object does not imply that the test execution tool will recognize it, too.
- If you already have a GUI prototype of your application, you can use the **GUI Spy** to record all of its windows. This method is very effective and saves a lot of work. A special AddIn is available for recording Java GUI´s.
- If you're using HP QuickTest, you can import QuickTest object repositories directly into IDATG. This is especially useful for GUI technologies not supported by the IDATG **GUI Spy**.

8.1.2 Completing the Static GUI Information

- If you do not have a GUI prototype, missing windows can be added manually in the **Window Editor**. Common windows like Message Boxes can be generated easily with the **Window Wizard**.
- Depending on the window type, you can define various features with the **Window Properties Editor**. For instance, you may want to replace the proposed window ID by a more intelligible name. It is also particularly important to define a correct tag that will allow the test execution tool to recognize the window. In most cases, IDATG generates an appropriate tag automatically, but there may be a few special cases that require manual editing. (Please refer to chapter 10.6 for more information) You can also define the initial value of windows that take user input like input fields or check boxes.
- The window hierarchy of the application may be changed in the **Application Editor** by dragging child windows over their new parents.

8.1.3 Assigning Task Steps to GUI Objects

- As soon as the GUI layout is available, it is possible to assign the steps of the task flows to GUI objects using the toolbar button '**Assign Object to Step**'.
- Instead of filling out the field '**Test Commands**' in the **Step Editor**, you may enter one of the pre-defined user actions in the field '**Event**' (Click, Input etc).

8.2 Window Types

This section describes the different window types supported by IDATG and the particularities that have to be observed during the GUI specification. It also provides a handy overview of all events, conditions and actions that can be used for each type.

The following table lists the designators that can be used for most window types:

Designator Name	Type	Description
#WindowID:$Caption#	(String)	The text that appears as part of the window to label it. To make one of the letters in the caption of a window the hotkey, precede it with an ampersand (&). (e.g. &File is displayed as File) Default: Empty.
#WindowID:$Exist#	(Bool)	True, if the window is currently existing. Default: True for the start window and the children that are activated by it, false for all other windows.
#WindowID:$Group#	(Bool)	Specifies the first control of a group of controls in which the user can move from one control to the next by using the arrow keys. All controls in the tab order after the first control with the Group property set to False belong to the same group. The next control in the tab order with Group set to True ends the first group of controls and starts the next group. Default: False.
#WindowID:$Tabstop#	(Bool)	Specifies that the user can move to this control with the TAB key. Default: True.
#WindowID:$Visible#	(Bool)	Determines whether or not the window is visible. Default: True.
#WindowID:$Enabled#	(Bool)	Determines if the window is enabled. Default: True.

Note that this section only points out the type-specific features of each window type. There is a number of general operations that can be used for (almost) all window types. For instance, the events *Click* and *Type* or the action *SetAttribute* can be used in most cases.

8.2.1 Check Boxes

Check Boxes have a value that may be either TRUE or FALSE (checked or unchecked). If the box has the property *Tri-state*, it can also have a third value UNDETERMINED. In this state the box appears to be grayed and checked. It is used e.g., if you have selected a set of files in the Windows Explorer and open the Properties dialog. If some of the files are read-only and the others are not, the check box *Read-only* in the dialog will have the state UNDETERMINED.
Note: Tri-state check-boxes are not supported by SilkTest.

Figure 16 - Check Box States

User events:
Change the state of a box: Check(*BOOL expression*)
Verify the state of a box: Verify(Value, *BOOL expression*)

Actions:
Specify that the state of a box has changed:
SetCheckBox(*#BoxID#*, *BOOL expression*)

Type-specific designators:

#CheckBoxID#	(Bool or "undetermined")	The current state of the check box, can be accessed with SetCheckBox(Name, Value). "Undetermined" is only allowed for tristate check boxes. Default: False.
#CheckBoxID:$Auto#	(Bool)	Creates a check box that, when selected, automatically toggles between checked and unchecked states. You must set this property to True if you are using a group of check boxes with Dialog Data Exchange. Default: True.
#CheckBoxID:$TriState#	(Bool)	Creates a three-state check box. A three-state check box can be grayed as well as checked or not checked. A grayed check box indicates that the state represented by the control is undetermined. Default: False.

8.2.2 Child Windows

The type Child Window should only be used for child frames of a MDI main frame. For instance, the **Window Editor** of IDATG is a child window of the main IDATG window. Child windows usually have a titlebar of their own, but cannot be moved outside their main window. This window type has nothing to do with the parent/child relationships between the windows!

Important: If you want to record a Child Window with the **GUI Spy**, we strongly recommend to restore it to its normal size before recording it instead of recording it while it is minimized or maximized! Otherwise the child frame may not be recorded properly. The property *Titlebar* should always be set to TRUE!
If the window is opened automatically together with its parent, the *Open Method* has to be set to *Parent*, otherwise to *Call*.

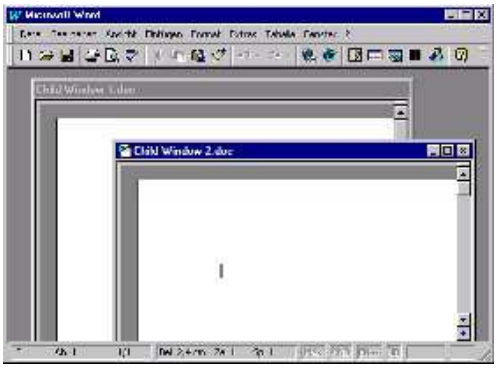


Figure 17 - Two Child Windows inside a Main Window

Like for all windows that have a titlebar, the following commands can be applied:

User events:

Minimize/Maximize/Restore the window:	Position(*MINIMIZE*|*MAXIMIZE*|*RESTORE*)
Resize the window:	Position(RESIZE, *Width, Height*)
Move the window:	Position(MOVE, *X, Y*)
Scroll the client area of the window:	Scroll(*Pages*, *V*|*H*)
Close the window:	Close

Actions:
Specify that the window has been opened: OpenWindow(#*WindowID*#)
Specify that the window has been closed: CloseWindow(#*WindowID*#)

Type-specific designators:

#ChildWndID:$Titlebar#	(Bool)	If True, the window has a titlebar. Default: True.
#ChildWndID:$SystemMenu#	(Bool)	If True, the window has a system menu that can be opened with the right mouse button. Default: True.

8.2.3 Combo Boxes

Combo Boxes combine the qualities of an input field with that of a list box. Their *value* is the contents of the input field. The value type may be STRING, NUM or DATE.

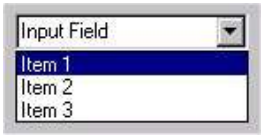


Figure 18 - Combo Box

Important: Combo boxes with BoxType *Droplist* only have a list, but no input field and thus no value. Some events and actions are not applicable for them.

User events:

Enter a specific text into the input field:	Input(*STRING, NUM or DATE expression*)
Click on a specific list item:	Select(*NUM expression*, [*Clicks*])
Click on the last list item:	Select(LAST, [*Clicks*])
Verify the contents of the input field:	Verify(Value, *STRING, NUM or DATE expr.*)
Verify the text of a specific list item:	Verify(Value, *NUM expr.*, *STRING expr.*)
Verify the text of the last list item:	Verify(Value, LAST, *STRING expr.*)
Verify which text is currently selected:	Verify(Selection, *STRING expr.*)

Actions:
Specify that the text of the input field has changed:
SetComboBox(#*BoxID*#, *STRING, NUM or DATE expression*)

Type-specific designators:

#ComboBoxID#	(String, Num or Date)	The current contents of the edit field of the box, can be accessed with SetComboBox(Name, Value) Default: Empty.

#ComboBoxID:$BoxType#	(“Simple“, “Dropdown“ or “Droplist“)	Specifies the type of combo box. This property can have one of the following values: Simple: Creates a simple combo box that combines an edit-box control which takes user input with a list control. The list is displayed at all times, and the current selection in the list is displayed in the edit-box control. Dropdown (Default): Creates a drop-down combo box. This type is the same as a simple combo box, except the list is not displayed unless the user clicks a drop-down arrow at the right of the edit-box control portion of the combo box. Drop List: This type is similar to the drop-down style, but the edit-box control is replaced by a static-text item which does not take user input that displays the current selection in the list.
#ComboBoxID:$Sort#	(Bool)	Sorts the contents of the combo box alphabetically. Default: True.

8.2.4 Custom Windows

All windows that have a classname unknown to the **GUI Spy** are recorded as Custom Windows. Most applications contain a lot of custom windows that are necessary for the program logic but are of little importance to the user (and the tester). They may also appear if the GUI programmers have introduced new window classes of their own instead of using the ones provided by the GUI builder. You can define their type later using the menu ‘**Change Window Type**’ or (even better) define the type before recording in the **Window Class Editor**.

If a custom window has a titlebar, the available designators, events and actions are the same as for Child Windows.

8.2.5 Dialog Boxes

Dialog Boxes are a basic component of most GUIs and are used for various purposes. The most common type has a titlebar of its own and is used to display other controls (e.g., a Message Dialog or Properties Dialog).
Sometimes dialog boxes are also used without a titlebar, e.g. as page of a tab control or inside a frame window. If the window is opened automatically together with its parent, the *Open Method* has to be set to *Parent*, otherwise to *Call*.
The property *System Modal* is particularly important. It has to be set to *TRUE* if the other windows of the application cannot be used while the dialog is open. In this case it also has to be specified how the dialog can be closed by drawing a transition with a *CloseWindow* action. Example: Error Message.
Please make sure that these properties are always set correctly!

Figure 19 - Dialog Box containing other Dialogs as Tab Pages

The available events and actions are the same as for Child Windows. In addition, there is a special action for opening a dialog box as system modal dialog: OpenModalDialog(*#DialogID#*)

Type-specific designators:

#DlgID:$Style#	(“Overlapped“, ”Popup“ or ”Child“)	Overlapped: Creates an overlapped window. An overlapped window is always a top-level window and should have a caption and a border. Popup (Default): Creates a pop-up window. Child: Creates a child window.
#DlgID:$Titlebar#	(Bool)	If True, the window has a titlebar. Default: True.
#DlgID:$SystemMenu#	(Bool)	If True, the window has a system menu that can be opened with the right mouse button. Default: True.
#DlgID:$SystemModal#	(Bool)	Creates a system-modal dialog box, which prohibits switching to another window or program while the dialog box is active. Default: False.
#DlgID:$Control#	(Bool)	Creates a dialog box that works well as a child window of another dialog box, much like a page in a property sheet. This style allows the user to tab among the control windows of a child dialog box, use its accelerator keys, and so on. Default: False.
#DlgID:$ControlParent#	(Bool)	Allows the user to navigate among the child windows of the dialog by using the TAB key. Default: False.

8.2.6 Group Boxes

Group Boxes are used to group a set of controls visually together. They become only important for the GUI specification if they contain radio buttons, because without group boxes IDATG cannot determine which radio buttons belong together. If a group box contains radio buttons, its value is determined by the caption of the selected radio button and the following operations are allowed:

Figure 20 - Group Box containing 2 Radio Buttons

User events:
Select a radio button: Select("*RadioButtonCaption"*)
Verify that a specific radio button is selected: Verify(Value, "*RadioButtonCaption"*)

Actions:
Specify that the selection has changed: SetRadioGroup(*#GroupID#*, "*RadioButtonCaption*")

Type-specific designators:

#GroupBoxID#	(Radio Button Caption)	The caption of the currently checked radio button in the group. The radio button must be positioned inside the group box. Group Boxes that do not contain radio buttons have no value. Can be accessed with SetRadioGroup(Name, Value) Default: Empty.

8.2.7 Headers

Headers are mostly used in list views to display the title of the list columns. Clicking on a column header usually sorts the list according to the elements in this column. Apart from that they do not have any special features.

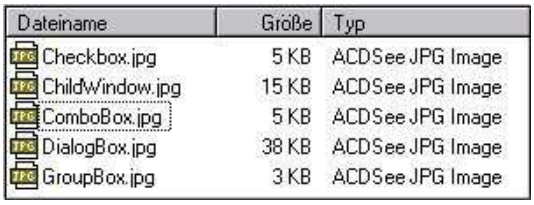

Dateiname
Größe
Typ
Checkbox.jpg 5 KB ACDSee JPG Image
ChildWindow.jpg 15 KB ACDSee JPG Image
ComboBox.jpg 5 KB ACDSee JPG Image
DialogBox.jpg 38 KB ACDSee JPG Image
GroupBox.jpg 3 KB ACDSee JPG Image

Figure 21 - List View with Header

8.2.8 Images

This window type is used for all kinds of icons, bitmaps or web images (exception: the type "Link" is used for clickable web images). In many GUI builders like Visual C++ and Java images are implemented as a special kind of static text object and even have the same classnames as ordinary texts (e.g., *Static* or *JLabel*). In case an image object consists of both an icon and a text it is possible to use the event Verify(CAPTION, "*ImageCaption*") to analyze the text.

8.2.9 Input Fields

Input Fields are very important in most GUIs, because they allow the user to enter a value. The value type may be STRING, NUM or DATE.

User events:
Enter a specific text into the input field: Input(*STRING, NUM or DATE expression*)
Verify the contents of the input field: Verify(Value, *STRING, NUM or DATE expr.*)

Actions:
Specify that the text has changed: SetInputField(*#FieldID#*, *STRING, NUM or DATE expr.*)

Type-specific designators:

#InputFieldID#	(String, Num or Date)	The current contents of the input field, can be accessed with SetInputField(Name, Value) Default: Empty.
#InputFieldID:$Multiline#	(Bool)	Creates a multiline edit-box control. When the multiline edit-box control is in a dialog box, the default result of pressing the ENTER key is to choose the default button. Default: False.
#InputFieldID:$WantReturn#	(Bool)	Specifies that a carriage return be inserted when the user presses the ENTER key while typing text into a multiline edit-box control in a dialog box. If this style is not specified, pressing the ENTER key has the same effect as pressing the dialog box's default push button. This style has no effect on a single-line edit-box control. Default: False.
#InputFieldID:$ReadOnly#	(Bool)	Prevents the user from typing or editing text in the edit box. Default: False.
#InputFieldID:$Number#	(Bool)	Prevents the user from typing non-numeric characters. Default: False.

8.2.10 Links

Links are used in HTML documents for navigating between different web pages. IDATG distinguishes 3 different types:

- Normal text links identified by underlined text and the key word *<A>* in the HTML source. WinRunner expects the classname **html_text_link**.
- Clickable images denoted by *<A><IMG><\A>* in the HTML source. They are depicted as a blue rectangle in IDATG. WinRunner expects the classname **html_rect**.
- Hotspots inside an image defined by a *<MAP><AREA><\MAP><IMG useMap>* construct. In IDATG, these hotspots are recorded as children of the image and get the classname **html_area**. They are also depicted as a blue rectangle. Since WinRunner does not support hotspots, a click on the appropriate coordinate of the image (i.e. the center of the hotspot) is generated instead.

Type-specific designators:

#Link:$URL#	(String)	The URL (web address) the link points to. Default: http://.

8.2.11 List Boxes and List Views

List boxes and list views are very similar, except that list views can have more than one column and support different display modes (a good example is the right part of the Windows Explorer). For the following commands only the text in the *first* column of a list view is relevant.

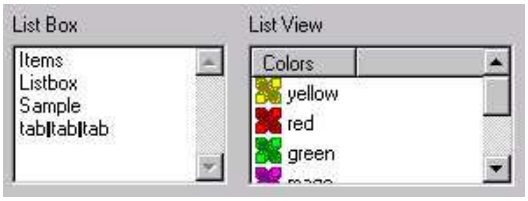


Figure 22 - List Box and List View

User events:

Click on a specific list item:	Select(*NUM expression*, [*Clicks*])
Click on the last list item:	Select(LAST, [*Clicks*])
Click on a specific text:	Select(*STRING expression*, [*Clicks*])
Verify the text of a specific list item:	Verify(Value, *NUM expression*, *STRING expression*)
Verify the text of the last list item:	Verify(Value, LAST, *STRING expression*)
Verify which text is currently selected:	Verify(Selection, *STRING expression*)

The following events can only be used if the list items are check boxes:

Change the state of a specific list item:	Check(*NUM expression*, *BOOL expression*)
Change the state of the last list item:	Check(LAST, *BOOL expression*)
Change the state of a specific text:	Check(*STRING expression*, *BOOL expression*)

Actions:

Specify that the text of a specific list item has changed:
SetListBox/SetListView(#*ListID*:$*RowNr*#, *STRING expression*)
Specify that the text of the last list item has changed:
SetListBox/SetListView(#*ListID*:$LAST#, *STRING expression*)

Note: Usually it is not possible to edit the contents of a list directly.

Type-specific designators:

#ListID:$x#	(String)	The current contents of row number x, can be accessed with SetListBox(Name, Value). x can be any integer number or LAST representing the last list item. Default: Empty.
#ListBoxID:$Selection# (only for ListBoxes)	(“Single“, “Multiple“ or “Extended“)	Determines how items in a list box can be selected. Possible values are as follows: Single (Default): Only one item in a list box can be selected at a time. Multiple: More than one list-box item can be selected, but the <SHIFT> and <CTRL> keys have no effect. Clicking or double-clicking an unselected item selects it. Clicking or double-clicking a selected item deselects it. Extended: The <SHIFT> and <CTRL> keys can be used together with the mouse to select and deselect list-box items, select groups of items, and select non-adjacent items.

#ListViewID:$SingleSelection# (only for ListViews)	(Bool)	Allows only one item at a time to be selected. By default, multiple items may be selected. Default: False.
#ListBoxID:$Sort# (only for ListBoxes)	(Bool)	Sorts the contents of the list box alphabetically. Default: True.
#ListViewID:$Sort# (only for ListViews)	("None", "Ascending" or "Descending")	Sorts the icons in the list in the following order: None: (Default): No sort applied. Ascending: Sorts items based on item text in ascending order. Descending: Sorts items based on item text in descending order.

8.2.12 Main Windows

The type Main Window is used for the main frame of a MDI application (e.g., IDATG). Typically, it has a titlebar and contains a menu, toolbars and one or more child frames. Note that the top window of an application is not always a main window (e.g., it can also be a dialog box like in the Demo application).

The available designators, events and actions are the same as for Child Windows.

8.2.13 Menus

Menus are only abstract objects used to group a set of menu items together. There are no operations for them.

8.2.14 Menu Items

Menu items are the constituents of a menu, they are organized in a tree structure. The following types can be discerned:

Figure 23 - Menu

Command Menu Item Clicking on an item of this type triggers a command. These are the only items that can be the start state of a transition (however, not the destination state). They do not have children. Some command menu items behave like a check box or radio button. In this case, the event Check(*BOOL expression*) may be used instead of a simple Click.

Popup-Menu Item Clicking on this item opens a list of other menu items (i.e. the children of the popup menu item)

Separator A separator is just a horizontal line that is used to visually group other menu items together.

Type-specific designators:

#MenuItemID:$Separator#	(Bool)	If True, the menu item is a separator. Default: False.
#MenuItemID:$Checked#	(Bool)	If True, the menu item is checked. Default: False.
#MenuItemID:$Popup#	(Bool)	If True, the menu item is a pop-up menu (a submenu).

		Default: True for top-level menu items on a menu bar; otherwise False.

Note: *$Visible* is not applicable for menu items. Use *$Enabled* instead.

Ampersands (&) in the caption are used in MFC to express short keys, but are not really part of the caption.
E.g. ('&New' in a resource file creates the menu item '**New**' with the short key <**Alt-N**>)

8.2.15 Push Buttons

Push Buttons are very common GUI elements and are the start states of most steps. However, they do not require any special operations in IDATG. A simple Click is enough in most cases.

Type-specific designators:

#PushButtonID:$DefaultButton#	(Bool)	If True, the control is the default button in the dialog box. The default button is drawn with a heavy black border when the dialog box first appears and is executed if the user presses ENTER without choosing another command in the dialog box. Default: False.

8.2.16 Radio Buttons

Radio Buttons never appear single, they always form a group that is usually surrounded by a group box. Checking one radio button causes all other buttons in the group to become unchecked. Therefore the caption of the checked radio button in the group is seen as its value. The individual radio buttons do not have a value of their own. E.g. you have to use *#Sex_GRP# = "Female"* instead of *#Female# = TRUE* (*Sex_GRP* is the ID of the radio group, *Female* the caption of the radio button)

Important: If a group of radio buttons is not surrounded by a group box, this is not only a weakness in the GUI design, but also a serious problem for some test execution tools. Therefore IDATG requires that all radio buttons must be surrounded by a group box and that two distinct groups of radio buttons must not lie within the same group box. If you have to specify a GUI where this rule has been violated, please ask the GUI designers to change the layout. If this should not be possible, you can draw appropriate group boxes around the buttons in IDATG. However, in this case there is no guarantee that the radio buttons will be recognized correctly by the test execution tool.

Note: Radio Buttons do not have a value. The checked radio button in a radio group is determined by the value of the surrounding Group Box. The available operations are listed under 'Group Boxes'.

Type-specific designators:

#RadioButtonID:$Auto#	(Bool)	When the user selects a radio button with this property, the radio button is selected automatically and all other radio buttons in the same group are cleared (deselected). Default: True.

8.2.17 Static Texts

Static texts are used to display messages or as description for other windows that do not have a caption of their own (e.g., input fields, lists). They cannot be changed by the user. Bitmaps also belong to this category.

8.2.18 Tab Controls

Tab Controls allow the user to switch between different pages of a window. Unfortunately, there are different ways to implement them, which causes different results when recording a tab control with the **GUI Spy**:

- If all pages exist at the same time (only one is visible at a time), the **GUI Spy** records all pages at once. The disadvantage is that the pages overlap and the IDATG user may get confused by the display in the **Window Editor**. The solution is to look at the window hierarchy in the **Application Editor** and to open the **Window Editor** for each individual page.
- If the pages are created dynamically, the **GUI Spy** only records one page at a time. This is less confusing but more work because each page has to be recorded and placed at the right spot in the window hierarchy individually.

Note that the **GUI Spy** sees only the information that a tab control is existing, but neither which choices it offers nor which dialogs become visible after the selection. Before you are able to use the operations below, you have to specify the titles of the tab pages and the windows they display. To make the specification of tab controls easier, IDATG provides a special **Tab Control Editor** that can be accessed via the **Window Properties Editor**.

Figure 24 - Tab Control with 3 Pages

User events:

Switch to a tab page: Select("*PageTitle*")
Verify which page is currently selected: Verify(Value, "*PageTitle*")

Actions:

Specify that another tab page opens: SetTabControl(#*TabID*#, "*PageTitle*")

Type-specific designators:

#TabCtrlID#	(String)	The title of the currently selected tab page, can

		be accessed with SetTabControl(Name, Value). Default: Empty.
#TabCtrlID:$Focus#	("Default", "OnButtonDown" or "Never")	Can be one of the following values: Default (Default): Specifies that the user can use the keyboard to give the input focus to a tab in the control. On Button Down: Specifies that a tab receives the input focus when clicked. Never: Specifies that a tab never receives the input focus when clicked.
#TabCtrlID:$MultiLine#	(Bool)	Displays multiple rows of tabs. Default: False.

8.2.19 Tables

The window type Table can be used for all kinds of two-dimensional arrays and grids. The cells of a table can be accessed individually by using their column and row number in the form *#TableID:$row,column#*. Note that WinRunner starts counting with 0, whereas SilkTest starts with 1. Most tables require a special plug-in that enables the test execution tool to recognize them.

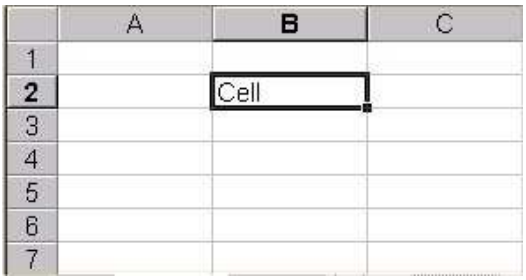


Figure 25 - Table

User events:

Click on a specific table cell: Click(*Row*, *Column*, [*Button*], [*Clicks*])
Enter a text into a table cell: Input(*Row*, *Column*, *STRING expression*)
Verify the text of a table cell: Verify(Value, *Row*, *Column*, *STRING expression*)

Actions:

Specify that a table cell has changed: SetTableCell(*#TableID*:$*Row,Column#*, *STRING expr.*)

Type-specific designators:

#TableID:$x,y#	(String)	The current contents of the table cell in row x and column y. It can be accessed with SetTableCell(Name, Value). x and y can be any integer number. Default: Empty.

8.2.20 Tool Bars

Tool Bars usually contain a set of buttons or other controls that allow the user to trigger certain commands. Unfortunately, the strange design of many new Microsoft ® applications makes these controls invisible to both the IDATG **GUI Spy** and the test execution tools. Therefore it is recommended to test via the menu instead whenever possible.

If you are using WinRunner, you can also try to use the following event, even if the tool bar buttons are not recognized: Click(*ButtonIndex*, [*Button*]). In many cases this produces satisfying results.

Figure 26 - Tool Bar containing "Buttons" and Combo Boxes

8.2.21 Tree Controls

Trees are used to display a set of hierarchically structured items. To access an individual item, you have to write the names of all its parent nodes starting from the root node separated by '|' (e.g., *Root Node*|*Expanded Node*|*Leaf*).

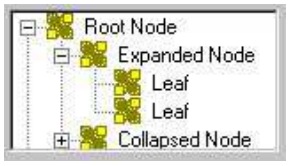


Figure 27 - Tree Control

User events:

Select an item: Select(*STRING expression*, [*Clicks*])
Expand a tree node [+]: Expand(*STRING expression*, 1)
Collapse a tree node [-]: Expand(*STRING expression*, 0)

The following event can only be used if the tree items are check boxes:
Change the state of an item: Check(*STRING expression*, *BOOL expression*)

Type-specific designators:

#TreeCtrlID:$HasButtons#	(Bool)	Displays plus (+) and minus (-) buttons next to parent items. The user clicks the buttons to expand or collapse a parent item's list of child items. Default: False.
#TreeCtrlID:$EditLabels#	(Bool)	Allows the user to edit the labels of tree view items. Default: True.

8.3 Web Testing

IDATG provides a number of powerful features that allow you to generate test cases for webpages:

- Interface to MS Internet Explorer that allows you to record webpages directly from the screen with the **GUI Spy**.
- **Java Interface** for recording Java Applets contained in a webpage (see User's Guide Part II)
- Specific representation of links and other HTML objects in the **Window Editor**.
- Generation of GUI maps and scripts suited for web testing.

8.3.1 Recording Webpages

IDATG uses the COM interface of Internet Explorer to retrieve information about the displayed objects. Thanks to the cooperation of the Microsoft support it was even possible to overcome certain access restrictions in HTML frames.
We are proud to say that it is not necessary that you open the IE **after** IDATG like it is required by some execution tools. The user does not even notice that a different interface is used when he drags the cursor of the **GUI Spy** into a webpage. The objects under the cursor are highlighted in red like all other windows on the screen, even if they are inside a frame or if the page is scrolled!
To avoid difficulties, please use IE Version 5.5 or higher. Netscape or other browsers are not supported. The same applies to IE windows that are embedded in other applications (e.g. online help). Note that these restrictions only apply to recording - the generated scripts can also be used for testing with other browsers.

Which objects are recorded?
IDATG records all HTML objects that are relevant for GUI testing like links, input elements, frames and images. Static texts and formatting elements like HTML tables are ignored to keep the amount of data manageable for the user. Objects that are smaller than 3 pixels are also ignored.

The following table gives a short overview over the recorded objects and their representation in IDATG. Unlike WinRunner, IDATG is even able to record hotspots inside an image (AREAs). When exporting WinRunner scripts, a click on the appropriate coordinate of the image is generated.
Since IDATG requires that Radio Buttons must be surrounded by a Group Box, an appropriate box is created automatically. Of course, this has no negative effect on the WinRunner scripts.

HTML Tag	IDATG Window Type	Classname
A	Link	html_text_link
AREA	Link	html_area
BUTTON	Push Button	html_push_button
FRAME, IFRAME	Custom Window	html_frame
IMG	Image, Link (if clickable)	html_rect
INPUT (button)	Push Button	html_push_button
INPUT (checkbox)	Check Box	html_check_button
INPUT (file)	Input Field	html_file
INPUT (image)	Image	html_rect
INPUT (radio)	Radio Button, Group Box	html_radio_button, html_group
INPUT (text)	Input Field	html_edit
SELECT (height <= 30)	Combo Box	html_combobox
SELECT (height > 30)	List Box	html_listbox
TEXTAREA	Input Field	html_textarea

Recording a complete webpage
If you wish to record all HTML objects in a webpage, just select '**Record complete webpage**' before dragging the mouse over the IE window. After recording, the webpage itself will be represented by a custom window with classname *html_frame*. The recorded objects will be placed into this frame as children.

8.3.2 Running Scripts for Web Testing

If you have generated test cases for a web application and wish to convert them into scripts, check '**Web Test**' in the **Test Case Converter**. Instead of the path to the executable like for normal applications, you have to enter the internet address (URL) of the webpage. When running your scripts, the Internet Explorer will be opened automatically showing the page you specified. If you wish to test with other browsers, change the *web_browser_invoke* command in the script accordingly.
The utmost deliberation has been used to guarantee that all objects contained in the generated GUI Maps are recognized without problems. Sometimes the classname or caption of an object may seem quite strange after recording it with IDATG, but usually the test execution tool expects it this way.

9 Multi-User Support

IDATG provides a master/sub project mechanism to enable multiple users to work in parallel. The idea is to have commonly used building blocks, windows etc. in a central repository (the master project) that can be referenced by various sub projects. This also greatly enhances the maintainability of your tests.

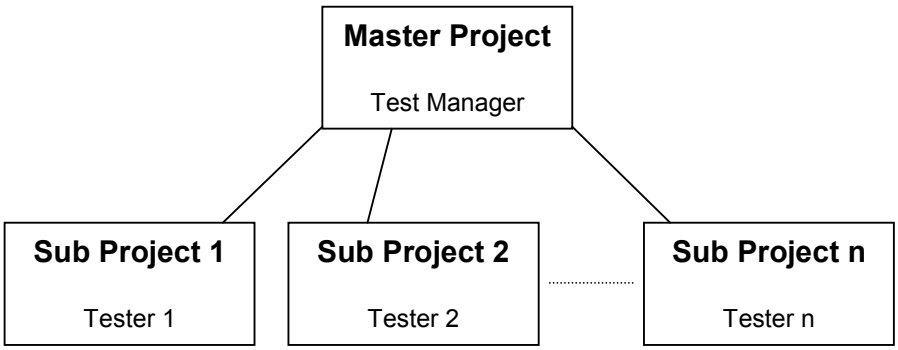


Figure 28 - Master / Sub Project Structure

9.1 Working with Sub Projects

- Create the master project by constructing a normal IDATG project.
- Specify all data that is required by more than one tester. This may include requirements, windows, building block tasks, test data, global attributes etc. For instance, if nearly all your test cases begin with entering a user name and password, you may want to add a building block 'Login' and the login window.
- For each tester, create a sub project by using the menu '**Project|Administration|Create Sub Project**'. A sub project automatically has the same properties as its master.
- Inside a sub project, all data from the master is displayed, but cannot be changed. However, you may add new data and use references to items of the master project. For instance, you may use the master's building blocks in your task flows or assign its windows to your task steps.
- Each tester may work independently from his colleagues by editing his own sub project while the test manager is responsible for keeping the master project up to date.

9.2 Editing the Master Project

In order to avoid data inconsistencies, the following points have to be considered:

- New data may always be added to the master project.
- Existing data may only be deleted if it has not been referenced in a sub project. Otherwise a warning is issued when the sub project is next opened.
- Do not change IDs / names of objects that have been referenced in a sub project. For instance, renaming the task *Login* to *SignOn* is not a good idea if your sub project contains an event *Input(#@Login:Username#)*. The same goes for the name of the parameter *Username*. Other object properties may be freely edited.
- A master project may not have a master of its own.
- After editing and saving the master project, all sub projects should be re-opened to update the relevant information.
- If the master project itself has been renamed or moved to a different directory, you may enter the new path in the sub project's **Project Administration Dialog**.

9.3 Merging a Sub Project with its Master

Sometimes it may be required to merge the master project with one of its sub projects into a single file. In this case, just open the sub project and use the menu '**Project|Administration|Merge with Master Project**'. The immediate effect is that all master data now belongs to the current project and becomes writeable. You may now use the '**Save**' function to save the merged project to the ex-sub project file or '**Save As**' to create a new file. The original master file is not affected by this procedure.

9.4 Transferring Data between Sub Projects

Using the function '**Project|Import|Project Data**' it is possible to transfer all kinds of project data between projects. For instance, it is possible to select and copy building blocks, requirements, or windows if they are needed in another sub project.

10 Test Case Generation

This chapter describes the various kinds of test cases generated by IDATG and the output of the tool-specific test case conversion.

10.1 Graph-oriented Test Cases

When generating graph-oriented test cases, three options are available: Create 1 Test Case, Step Coverage and Connection Coverage. The first case is trivial, and for most task flow diagrams, there is little difference between the two other selections. However, it can be relevant in a case like the following:

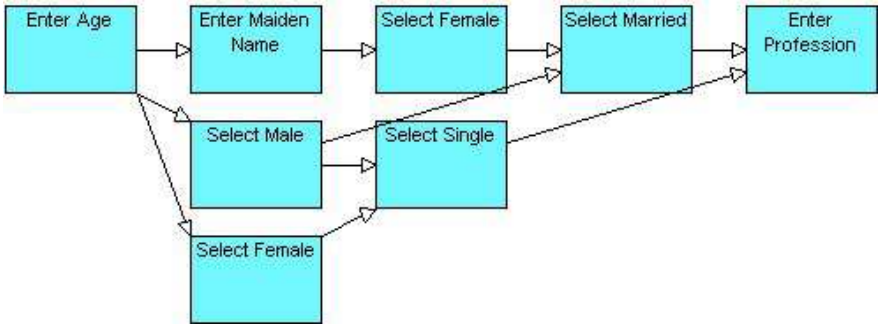


Figure 29 - Task Flow (Example)

For covering all steps (nodes in the graph), 3 test cases would be sufficient. However, covering all connections (edges in the graph) requires 4 test cases.

The generation process works as follows:

1. The user selects a use case task and starts the generation.
2. All sub task steps (yellow) in the use case task are replaced with the entire task flow of the sub task.
3. Step 2 is repeated until only atomic steps (blue) are left.
4. Starting with the first step of the use case task, a valid path through the task flow is searched. For each step, the following happens:
   - Select a successor of the current step. The algorithm prefers steps that have not yet been used in other test cases. In case of doubt the successor with the highest priority is used.
   - Check if the successor's conditions are fulfilled, if not try another path.
   - Create a new test step based on the successor and append it to the generated test case.
   - Replace all designator names in the step's test commands etc. with the current values.
   - Simulate all actions defined for a step e.g. by setting a designator to a new value.
5. When the final step of the use case task is reached, the new test case is completed.
6. Steps 4+5 are repeated until all steps or connections of the use case task are covered.

10.2 Data-oriented Test Cases

The algorithm for generating data-oriented test cases is pretty much the same as the one for graph-oriented testing. The main difference is that it does not try to cover all steps or connections of the task flow but rather tries to generate one valid path for each data record that has been defined. Ideally, the records of a data set should be designed in a way so that all steps/connections of the associated use case task are covered anyway.

10.3 Random Test Cases

For detailed information on random test generation, please refer to chapter 6.

10.4 Transition Test Cases

Apart from defining entire test sequences with task flow graphs it is also possible to specify a set of individual state transitions. Based on the pre-conditions and effects (actions) that have been defined for each transition, IDATG is able to generate a valid sequence automatically. The highly complex generation algorithm has even been patented. The goal is to test all transitions at least once.

Problem Description
When searching for a test case that includes a specific transition T, IDATG has to find 2 paths:

- A path P1 beginning in the initial state of the GUI and ending in a state where all conditions for T are fulfilled
- A path P2 beginning in the state produced by T and ending in a final state of the GUI (i.e. the test case ends with a CloseApplication action)

To produce a valid test case, the 2 paths have to be connected with the transition T:

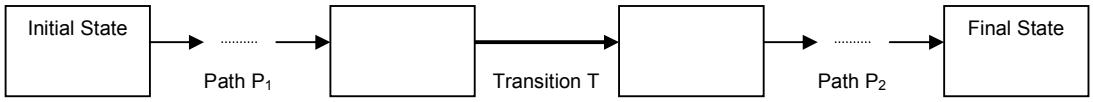
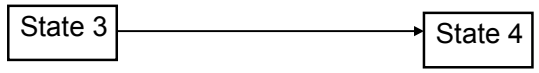


Figure 30 - Structure of a Transition Test Case

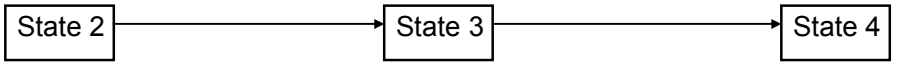
Searching a Path that fulfills a certain Condition
Most transitions depend on semantic conditions, for example a certain window has to be active before the transition can be tested. As we know, IDATG enables the developer to express a wide range of complex semantic dependencies in a GUI. These dependencies are a problem for TCG, since considerable effort is necessary in order to create semantically correct test cases.

Let us assume for example the following transition:



Condition: *#Delete:$Enabled# = TRUE*
Action: (none)

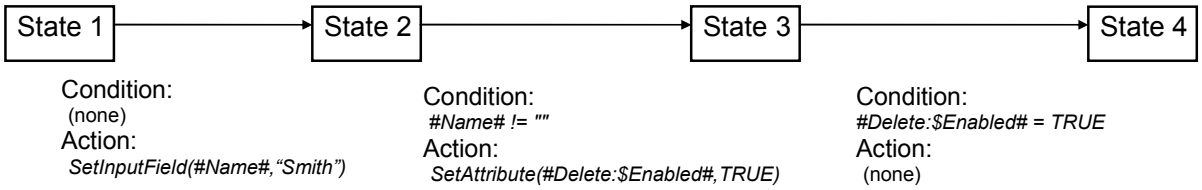
Before testing this transition, it is necessary that the *Delete* button is enabled. In our example, the button is initially disabled. Thus, the first step for TCG is to find a transition that sets *#Delete:$Enabled#* to the required value and to add it to the test case.



Condition: *#Name# != ""*
Action: *SetAttribute(#Delete:$Enabled#, TRUE)*

Condition: *#Delete:$Enabled# = TRUE*
Action: (none)

A transition with an appropriate action has been found, but it also depends on a condition (the field *Name* must not be empty). The procedure has to be repeated recursively until the test case is executable.



After adding another step that enters a value into the field *Name*, the test case is now complete, since the first transition can be executed in the initial state of the GUI.

Of course it is also possible that a transition depends on more than one designator and that it triggers more than one action.

10.5 Output Formats

This section contains an overview of all output files that are generated by IDATG. For general information about the usage of capture-replay tools please refer to the respective manuals.

10.5.1 Plain Text

The simplest method for producing a test script is to export the generated tests without further translation. If this option is selected in the **Test Case Converter**, IDATG copies the user-defined test commands for each step directly into the test script. When defining the test commands you may use designators that are replaced with their actual values during test case generation. See the section about the **Step Editor** in User's Guide Part II for an example.
A separate file is produced for each test package (window with own titlebar or use case task). The default extension of the produced scripts is *.txt*.

This format is the best option for producing manual test cases. For scripts that shall be executed automatically, the next format is recommended.

10.5.2 Universal File

This type is pretty much the same as "Plain Text", since the tests are exported without further translation. However, there is the difference that when using IDATG together with TEMPPO Test Manager, the test cases are marked as "Universal File" and can be run automatically from within TEMPPO Test Manager. This can be used for producing automated scripts that are not executed by a GUI testing tool but by a tool that uses some other interface to access the system under test.

10.5.3 QuickTest Professional (HP)

IDATG supports QuickTest version 11 and later. It makes use of QuickTest's Automation Object Model that allows IDATG to connect directly to QTP and to control it remotely via its COM interface.

10.5.3.1 Importing a QTP Object Repository

As an alternative to using the built-in GUI-Spy of IDATG, GUI info can be imported directly into IDATG from an Object Repository recorded with QTP. This is particularly useful in the following cases:

- For testing GUI technologies that are supported by QTP, but not by the IDATG GUI Spy (e.g., SAP, WPF)
- For guaranteeing optimal compatibility of the GUI description with QTP. The chance that a GUI object is correctly identified by QTP during a test run is increased if the original information recorded by QTP itself is used.

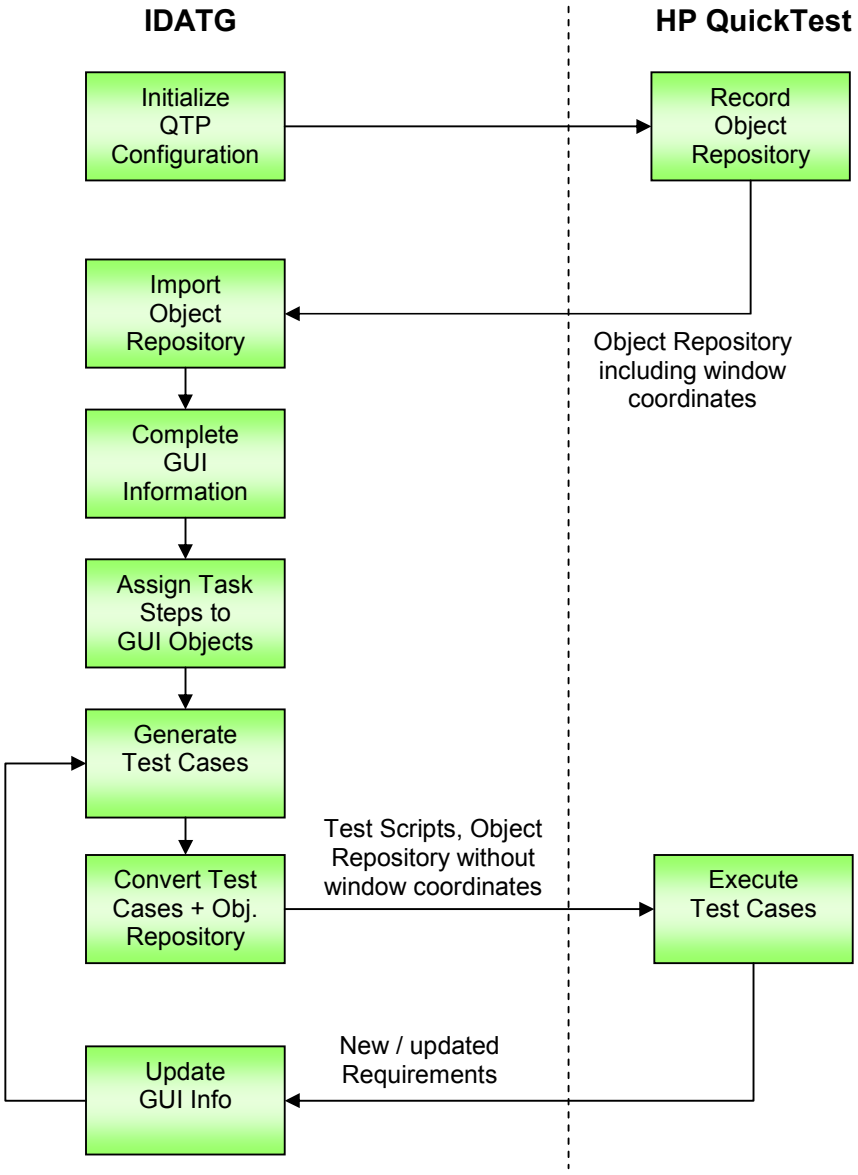


Figure 31 - Process for working with an imported QTP Object Repository

Please note that unlike the IDATG GUI Spy, QTP does usually NOT record coordinate and size information for the windows. Thus, screenshots of the imported windows could normally not be shown in the IDATG **Window Editor** (since all imported windows have size zero). To avoid this problem, the recording options of QTP have to be modified so that the properties x, y, width, and height are recorded for all window types (there are a few exceptions for which abs_x and abs_y have to be used instead of x and y). For your convenience, IDATG can configure QTP automatically.

Note that the coordinate and size information is only used for creating a graphical representation of the windows in IDATG. It will not be used for identifying the windows in QTP, since coordinate-based identification is very insecure and error-prone.

The following steps are necessary to import a QTP Object Repository:

- Make sure that QTP is correctly installed on your system including any add-ins required for the application you want to test (e.g., Java, Web).
- Start QTP once and activate the required add-ins, but do NOT select the Siebel add-in as it seems to cause problems. Then close QTP.
- BEFORE recording an Object Repository, you have to initialize the QTP recorder settings so that the properties x, y, width, and height are recorded for all window types. This can be done very easily by clicking the menu '**Project|Import from HP QuickTest|Initalize QTP Object Repository Options**' in IDATG. This step has only to be done once.
- Open QTP and create a new Object Repository by recording the desired windows. Please refer to the QTP user guide for more information. Save the Repository as .tsr file.
- In IDATG, choose '**Project|Import from HP QuickTest|Import QTP Object Repository**'. Select the desired .tsr file. IDATG tries to connect via the COM interface to the QTP Object Repository Utilities. If successful, all GUI objects contained in the .tsr file will be imported into IDATG.
- The .tsr file may now be deleted, since IDATG will generate a new one anyway (without the coordinate and size info).
- In case you wish to reset the QTP settings to their original state, just use the IDATG menu '**Project|Import from HP QuickTest|Reset QTP Object Repository Options**'.

Note: Since menu items are not recorded by QTP, they cannot be imported. Menus have to be recorded with the IDATG GUI Spy or drawn by hand in the **Menu Editor**.

10.5.3.2 Editing Window Properties for QTP

QTP supports a wide range of possibilites for identifying GUI objects. Since a simple tag string in IDATG would not be sufficient for that purpose, a special editor is available that allows to edit the QTP properties of a window in more detail.
It can be reached via the '**QTP Properties…**' button in the **Window Properties Editor**. If QTP is selected as output format and QTP properties are defined for the selected window, the button becomes visible and replaces the **Tag** field.

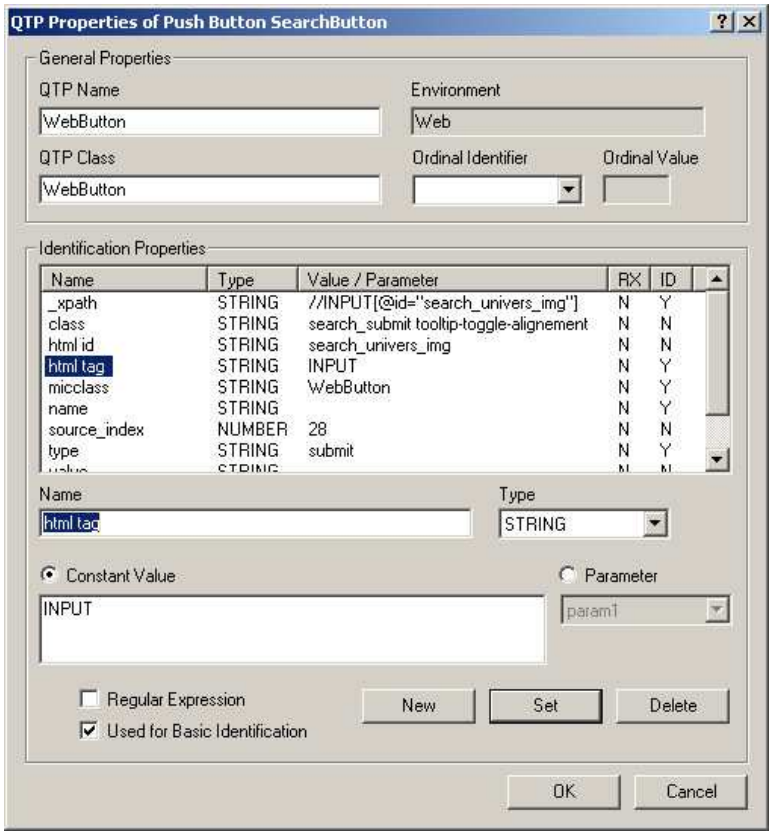


Figure 32 - QTP Properties Editor

The following properties are displayed:

- **QTP Name** The name used for identifying the window in QTP. Can be freely selected and is independent from the IDATG Window ID.
- **QTP Class** The internal QTP class to which the window is mapped (e.g., WebButton, WinTreeView etc.). The value entered here must be a valid QTP class name.
- **Environment** The GUI technology which depends on the QTP Class and cannot be edited directly (e.g. "Web" for WebButton, "Standard Windows" for WinTreeView).
- **Ordinal Identifier and Value** If two or more GUI objects have exactly the same identification properties, they can be distinguished by their position in the parent window ("Location"), the internal ordering ("Index") or the "CreationTime" (only for Browsers). If required, choose one of these settings and enter the corresponding number in the nearby field. Note that when counting ordinal values QTP starts with 0, not with 1.

The other **Identification Properties** may be different for each window and are displayed in a list. Editing these properties works in much the same way as in the **Attributes Editor**.

- Each property consists of a **Name** and **Type**. Allowed QTP types are **STRING**, **NUMBER**, **BOOL** (0 = False, -1 = True), and **I2** (a special type of integer that is only used in rare cases).
- A property can either have a **Constant Value** or a dynamic value defined by a **Parameter**. In all exported repositories, 3 standard parameters are defined that can be used freely. They are called *param1*, *param2*, *param3*.
- The box '**Regular Expression**' may be checked to indicate that the **Value** shall be interpreted by QTP as a regular expression. This can be useful, e.g., to specify strings that are changing dynamically.

- The box '**Used for Basic Identification**' determines if QTP uses this property for simple identification of the window. If it is not checked, this means that either QTP does not use the property at all or that it uses its Smart Identification algorithm.
- Please refer to the QTP help for finding out which properties are supported by each QTP class. In IDATG, you are free to enter any data for the QTP properties, but you are responsible yourself for making sure that the data is correct.
- Unlike QTP, IDATG displays ALL recorded properties, also the ones that are normally hidden by QTP. So do not be surprised if the list is longer than the one shown in QTP.
- At the moment, the "Smart Identification" feature of QTP cannot be edited directly in IDATG. However, Smart Identification data will be stored for windows imported from QTP and written to the QTP Object Repository generated by IDATG.

Setting Parameter Values in a Test Script
Before using a parameterized object, the value of the parameter needs to be set:

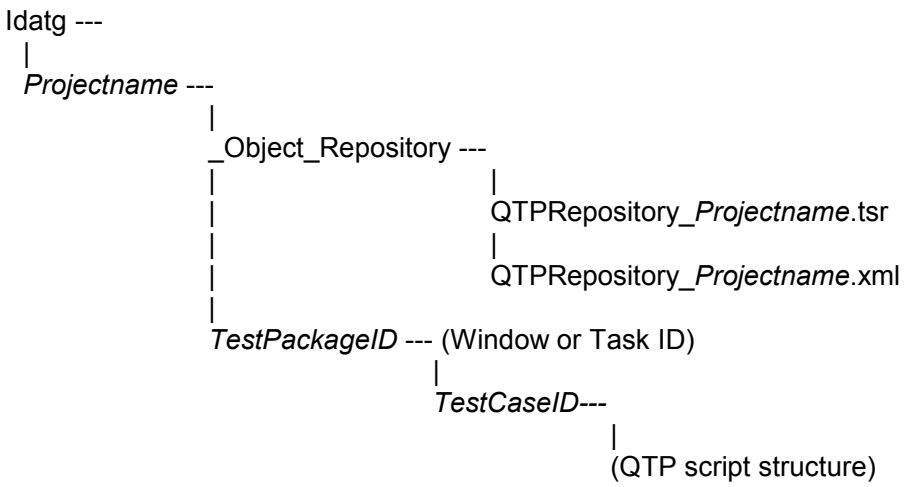
- In the **Task Flow Editor**, insert a step with the following **Commands for Test Script** directly before the step in which the object is used:
  ```
  Repository.Value ("<paramName>") = "<value>"
  ```
  Example:
  ```
  Repository.Value ("param1") = "my text"
  Browser("MyPage").Link("ParametrizedLink").Click
  ```
  Assuming that the object *ParametrizedLink* has a property *text* assigned to *param1*, QTP will search for a link with the text *my text* and click it.
- The same parameter can be reused and changed multiple times in a test case if required.

10.5.3.3 Exporting Test Scripts for QTP

After generating test cases, IDATG can convert them into complete test scripts including Object Repository in QTP format. To make this work, a few points have to be considered:

- Make sure that QuickTest is correctly installed on your system including any add-ins required for the application you want to test (e.g., Java, Web).
- Before the conversion, make sure that all QuickTest windows are closed. If a process is hanging (*QTPro.exe*, *QTAutomationAgent.exe*, or any other process starting with "QT"), stop it using the Windows Task Manager.
- Start the conversion in IDATG's **Test Case Conversion Dialog**. Check '**Show QuickTest Window during Conversion**' if you wish that QTP shall be visible. This is recommended for being able to read any messages that QTP might show. You can also choose if IDATG shall '**Leave QuickTest open after Conversion**', e.g. if you want to run the test immediately afterwards.
- A window informing you about the status of the conversion appears. First, IDATG tries to connect via the COM interface to the QTP Object Repository Utilities. If successful, the object repository is created and imported into QuickTest.
- Then, IDATG tries to connect via the COM interface to the main QTP application. If successful, QTP is launched and controlled remotely by IDATG.
- Launching QTP may take a while, especially if many add-ins have to be loaded. If QTP message boxes appear, check "do not show this message again" and close them.
- Once QTP is running, each test case is exported as a QuickTest "Test".

The following directory structure is created by IDATG:



The _Object_Repository directory contains the following files**:**

- QTPRepository_*Projectname*.xml - The object repository as XML file. This file is written by IDATG and contains information in text format.
- QTPRepository_*Projectname*.tsr - After QTP has imported the XML file, it saves the information in its proprietary TSR format.

For each test package (use case task of window with own titlebar), IDATG creates a separate directory. Within the test package, there is a sub-directory for each test case. QTP saves each test as a complicated set of files and directories in a proprietary format.

10.5.3.4 Trouble Shooting:

- **I am getting the message "QuickTest interface could not be initialized":** Make sure that QTP is properly installed and that a valid license is available. Check if QTP can be started manually on your machine.
- **I am getting the message "An open instance of QuickTest has been found":** If you find open QTP windows on your screen, close them. If no QTP windows are visible, QTP has probably crashed. In this case, start the Windows Task Manager and kill all processes starting with "QT".
- **QuickTest does not recognize any web objects in IE:** QTP can only recognize web objects in IE if you open IE after QTP. The reason is that the QTP agent needs to initialize its connection to IE. Once you have done this, you are free to close & reopen QTP, it is not necessary to reopen IE every time.
- **QuickTest keeps crashing:** For reasons unknown, QTP sometimes crashes without warning. As we are not in any way related to HP, we have no influence on this undesirable behavior. However, we have found that the following workarounds often help:
  - Make QTP invisible during the conversion by unchecking '**Show QuickTest Window during Conversion**'
  - Choose only the add-ins that are absolutely necessary when starting QTP. It seems that certain add-in combinations can cause problems. For instance, loading the Siebel add-in seems to have severe side effects.
  - QTP is very sensitive to errors in object repositories. Be careful when defining QTP object properties in IDATGr. For instance, if you define a property that doesn't exist for the current object type, QTP crashes as soon as you click on this object in the Repository Editor or try to run a script using this object.

10.5.4 Ranorex Studio

A first version of an interface to Ranorex Studio has recently been developed and supports the export of test cases for simple Win32 applications. It is planned to expand the interface in the near future in order to support other GUI technologies as well.

10.5.4.1 User Code in Ranorex

Apart from pre-defined Actions in Ranorex like "Mouse" or "Set Value", there is an Action "User Code" which gives the user the possibility to add arbitrary code in C#. This code is expected by Ranorex in the file *<Recording name>.UserCode.cs*. IDATG makes use of this feature in 2 cases:

1. for IDATG events that cannot be translated directly into a single Ranorex Action. Examples are selecting an item from a list or clicking a specific table cell. In such cases, IDATG copies the appropriate C# functions (e.g., SelectComboBoxItem) from the file *<IDATG installation folder>\RanorexAddIn\UserCodeMethods.txt* into the Ranorex user code file for the current test case/recording.
2. for steps where the field '**Commands for Test Script**' has been filled out by the user in the IDATG **Step Editor**. In this case, a new C# method containing the commands is created for each step and added to the user code file. The methods are named UserMethod_1(), UserMethod2(), etc. according to the sequence of user-defined steps in the test case.
   Editing the user code file directly in Ranorex makes little sense, since it will be overwritten next time you export the test cases with IDATG. Therefore, all changes should be made in IDATG. Please make sure to only specify valid C# code as '**Commands for Test Script**'.

10.5.4.2 Editing Window Properties for Ranorex

Ranorex uses a flexible concept for GUI object identification, consisting of the RanoreXPath and a list of capabilities for each object. Since a simple tag string in IDATG would not be sufficient for that purpose, a special editor is available that allows to edit the Ranorex properties of a window in more detail.
It can be reached via the '**Ranorex Properties…**' button in the **Window Properties Editor**. If Ranorex is selected as output format, the button becomes visible and replaces the **Tag** field.

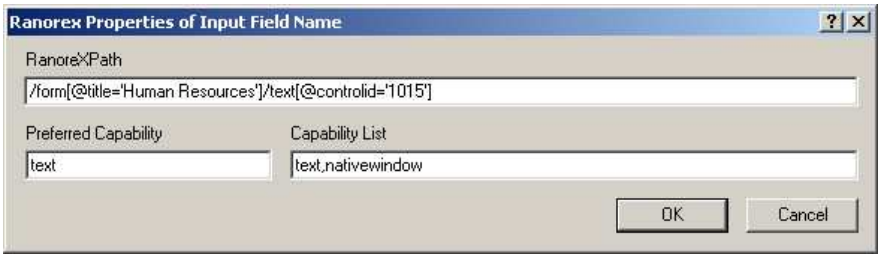


Figure 33 - Ranorex Properties Editor

The following properties are displayed:

- **RanoreXPath** This string is used to uniquely identify GUI elements within an application. Its syntax provides a wide range of possibilities including the use of regular expressions. For detailed information, please refer to the Ranorex user guide.
- **Preferred Capability** Each GUI object may have one or more "capabilites" or roles that define which Ranorex methods can be used on it. The "preferred capability" can be compared to the window type in IDATG (e.g., the preferred capability for the IDATG type "input field" is "text").
- **Capability List** This field contains ALL capabilites that are applicable for the GUI object, including the preferred capability. The capability names are separated by commas.

10.5.5 Silk Test (MicroFocus)

Please note that IDATG only supports older SilkTest versions that are using 4Test as scripting language. Newer versions using Visual Basic are currently NOT supported.

Starting at the root directory that the user specified in the **Test Case Converter**, IDATG generates the following directory structure:

```
Idatg ---
  |
  Projectname ---
                |
                Includes
                |
                Test_Suite
```

The *Includes* directory contains the following files**:**

- Incl.inc - The master include file containing a list of all other includes. It is referenced by all test scripts.
- Idatglib.inc - A file containing IDATG-specific functions that are called from the generated test scripts. It can be used for adding user-defined functions that set a certain application base state or recover from errors. Please consult the SilkTest documentation for more info on functions that are called automatically when entering/leaving a script or test case (e.g., ScriptEnter, TestcaseEnter). Note: this file is not overwritten if it already exists to avoid that your user-defined functions are lost.
- MainWin.inc - the window definition of the application's start window
- *WindowID*.inc - one file for each remaining window with own titlebar. It contains the window definition.

The following files can be found in the *Test_Suite* directory:

- Main.pln - The master test plan containing calls to all other test scripts. Just execute this file if you want to perform a complete test.
- *WindowID*.pln - one file for each window with own titlebar. This is the test plan that calls all test cases for this window.
- *WindowID*.t - one file for each window with own titlebar. It contains the test cases for this window.
- *TaskID*.pln - one file for each use case task. This is the test plan that calls all test cases for this task.
- *TaskID*.t - one file for each use case task. It contains the test cases for this task.

10.5.6 TestPartner (MicroFocus)

IDATG provides an interface to MicroFocus's test-scripting, -recording, and -execution tool TestPartner. TestPartner provides test creation by both visual tests (screenshot-based) and test scripts. Test scripts are written in Visual Basic and can be automatically recorded from the actions of the user on a given application's GUI. All elements created in TestPartner (like test scripts and visual tests, also called "Assets") are stored and managed in a database, providing version management. IDATG is able to convert test cases for TestPartner, automatically import them into TestPartner's database and run them without having the TestPartner GUI started.

Exporting test cases to MicroFocus TestPartner

Within the test script directory that the user specified in the **Test Case Converter**, IDATG creates a new project output-folder with the name of the active project.
Note: If that folder already exists, all files in that folder will be deleted! (to prevent old output files to be re-imported together with the new ones).

In the project-output-folder, the following files will be created:

File	Content description
TESTSUITE.xml	Contains • the *<Projectname>_MAIN* script that has to be executed in order to run all testcases recently exported • the *<Projectname>_INCLUDES* script that containing custom VB functions of IDATG
Testpackage_A.xml Testpackage_B.xml …	The single test packages of the project, each containing the several test cases generated for that package, e.g. Testpackage_A_1, Testpackage_A_2 …

After successful conversion, the **TestPartner Database Dialog** shows up, where you can specify whether to import the converted test scripts automatically into TestPartner's database. For detailed information on this dialog, please refer to User's Guide Part II.

10.5.7 WinRunner (HP)

Important: Before you can run the generated scripts, you have to prepare WinRunner with the steps described in the installation chapter. Otherwise IDATG-specific commands like *m_report* or *m_verify* are not recognized by WinRunner and the scripts cannot be executed.

The following tool-specific options are available for WinRunner in the **Test Case Conversion Dialog**:

Window Time-Out: Specifies the time in seconds that WinRunner should wait for a window to pop up. This value will be used as parameter for the *set_window* command. The default time-out is 20 seconds.

Optimize Wait Commands: By default, the delay defined for a test step is used as parameter for the following *set_window* command if possible. In this case, the test continues as soon as the specified window is available resulting in faster test execution. If you prefer instead that WinRunner always waits until the full delay time is over, you can uncheck this option causing IDATG to generate simple *wait* commands.

Keyboard Layout: WinRunner expects key names that depend on the keyboard layout (!) This means that a WinRunner script created on a PC with a German keyboard won't run on a PC with an English keyboard. To make things worse, the key names cannot be found in any user documentation...

Extra Variables: This field is only necessary if you wish to enter WinRunner-code directly into the **Step Editor** field '**Commands for Test Script**'. Sometimes it may be necessary to define additional WinRunner variables at the beginning of the generated functions. In this case, just enter there names here separated by spaces.

Starting at the root directory that the user specified in the **Test Case Converter**, IDATG generates the following directory structure:

Idatg ---
|
Projectname ---
|
Gui_Maps
|
Test_Suite ---
|
Main (WinRunner script structure)
|
TP_*WindowID* --- (or TP_*TaskID*)
|
Main (WinRunner script structure)
|
Func_Lib (WinRunner script structure)

The directory Gui_Maps contains a GUI map for each top-level window called *WindowID*.gui.

Due to the special requirements of WinRunner the script structure is a bit more complicated than for SilkTest. Each **bold** directory in the figure represents a WinRunner test script that consists of a file *script* and the WinRunner-specific sub-directories *db* and *exp*.

a) Main
Script - The master test script containing calls to all other test scripts. Just execute this file if you want to perform a complete test.

b) TP_*WindowID* or TP_*TaskID*
For each window with own titlebar a test package is generated. The same applies to all use case tasks. A test package consists of 2 separated scripts:

I. Main
Script - The main test script for this window that calls all test cases in the function library.

II. Func_Lib
Script - The function library for this window containing all test cases.

10.5.8 XML for ESA Test Commander

IDATG is part of the intelligent test framework of the European Space Agency ESA. Thus, IDATG is able to export special XML files that are suited for ESA's Test Commander tool. For further information, please refer to User's Guide Part II.

10.5.9 XML for TEMPPO Test Manager

IDATG includes a convenient interface to TEMPPO Test Manager. For detailed information, please refer to section 11.1.2.

10.5.10 Excel File for HP Quality Center

For details on how to export IDATG test cases to HP Quality Center, please refer to section 11.2.

10.6 Resolving Window Recognition Problems

10.6.1 Finding Correct Tags

The window tag is a kind of description that is required by the test execution tool to find the window on the screen. It is very important to enter a correct tag for each window, otherwise the generated test scripts won't run! In most cases, the **Tag Generator** will create correct tags for you, so you don't have to define them by hand

In some rare cases the test execution tool may report an error like "Object XY not found". The following procedure will resolve this problem:

- Open the 'GUI Map Editor' if you are using WinRunner or the 'Record Window Declarations' dialog if you are using SilkTest.
- Open the affected window in your application
- 'Learn' or 'record' the object that has not been recognized correctly
- Copy the correct tag into IDATG's **Window Properties Editor**.
  For **WinRunner**, this is the entire 'physical description' including the curly braces:
  e.g. *{class: edit, MSW_class: "!Edit", MSW_id: 1014}*
  For **SilkTest** it is the entire object description including keywords like *tag* or *parent*:
  e.g. *tag "[TextField]$1014"*

10.6.2 Window Properties used in Tags

The following list gives an overview of the most important window properties that are used as parts of the tag description:

Numeric ID (MSW_id)
In MS Windows-GUIs each window has a numeric ID that can convenienty be used as tag. Note that this doesn't work for windows with titlebars, because their ID changes dynamically.

Caption (Label)
If the window has some kind of name or title, it can easily be identified through it.

- WinRunner does not recognize numeric IDs of menu items. Tags are case-sensitive. Single characters can be replaced by a '.', but only if the tag is preceded by a '!' (e.g. "!ID.TG"). '*' signifies an arbitrary number of the previous character. For abbreviation you have to use '.*' (e.g. "!IDA.*").
- In SilkTest, tags are not case-sensitive and can be abbreviated with a '*' (but be careful, all tags in a window must be unique!). Single characters can be replaced by a '?' (e.g. "ID?TG").

Attached Text
If the window doesn't have a caption of its own (e.g., input field), the caption of a static text or group box in the proximity of the window can be used as tag. Note that the meaning of the term 'proximity' differs greatly depending on the test tool. Thanks to the cooperation of HP, IDATG uses the original WinRunner algorithm. For Java, SilkTest´s "attached text" algorithm contains serious bugs and cannot be used (especially for radio groups).

Index (Location)
This feature is particularly useful if there is more than one window with the same properties. In this case, the windows can be numbered from top left to bottom right thus enabling a unique identification. Note that SilkTest starts counting with 1 while WinRunner starts counting with 0.

Coordinates (x,y)
This alternative should only be used if no other method seems to work, since the coordinates of an object may change dynamically and depend on factors like the screen resolution.

11 Interfaces to Test Management

11.1 Interface to TEMPPO Test Manager

11.1.1 Opening IDATG directly from TEMPPO Test Manager

IDATG includes a convenient interface to TEMPPO Test Manager. After creating task packages in TEMPPO Test Manager, IDATG can be called directly in order to design tasks and generate test cases. When saving the project in IDATG, all data is sent back to TEMPPO Test Manager and stored in the TEMPPO database.

Designing IDATG tasks and test cases via TEMPPO Test Manager

- For using IDATG from TEMPPO Test Manager, it is necessary to activate the so-called IDATG mode, by ticking the checkbox “TEMPPO Designer (IDATG)” in tab “General” of the test structure’s root.
- As a preparation for designing test cases in IDATG, it is recommended to create so-called “Task Packages” in TEMPPO Test Manager. A task package is a special type of test package that is displayed with a blue icon and has the same attributes as a test case. You can create any kind of task package hierarchy.
- If you have finished creating some task packages in TEMPPO Test Manager, you can design and generate test cases by selecting a task package and calling the menu item “Tools=>TEMPPO Designer (IDATG)=>Design Test Cases”. The IDATG window will appear.
- When IDATG is opened, it displays the task packages defined in TEMPPO Test Manager as blue folders and automatically creates a use case for each leaf in the task package hierarchy.
- Now you have the possibility in IDATG to create task flows consisting of several steps. Of course, you can also create building block tasks. However, since they are not visible in TEMPPO Test Manager, they have to be put in ordinary yellow folders, not in the blue ones.
- If the user has finished the modeling process, he can start IDATG's test case generator.
- To import the designed tasks and the generated test cases into TEMPPO Test Manager, the user just has to press the "Save" button in IDATG. TEMPPO Test Manager receives the updated IDATG project and refreshes its test structure accordingly.
- For a **manual** test case only the generated steps are displayed in TEMPPO Test Manager. When you open the "Test Steps" tab in TEMPPO Test Manager, the columns "Instruction", Input", and "Expected" are mapped to corresponding step fields in IDATG:
- For an **automated** test case also the path to the generated test script is displayed. A test case is treated as automated, if it has at least once been exported by IDATG as a test script for an automation tool (e.g. TestPartner).

Rules and restrictions for TEMPPO Test Manager folders in IDATG

- In order to maintain the consistency with the test structure of TEMPPO Test Manager, the two topmost blue folders of the task hierarchy may not be edited in IDATG.
- Building block tasks may not be put in blue folders
- A use case may only be put in empty blue folders. If a blue folder already contains a use case, no other folders or use cases may be inserted.

- When dragging "normal" yellow folders into a blue folder, it is checked whether its contents complies with the above rules. If successful, the folder is converted into a blue folder.
- A use case in a blue folder always has the same name as the folder (except special characters and blanks that are removed from the use case name). If one of the names is changed, the other changes automatically. The names are also adapted automatically when dragging an item into a blue folder.
- While it is possible to create use cases in "normal" yellow folders, they will not be visible in TEMPPO Test Manager.

Restoring IDATG tasks and IDATG test cases from TEMPPO Test Manager

If the connection between TEMPPO Test Manager and IDATG is lost (e.g. because the user aborts it by pressing the button Cancel in the window “Connection Status”), it is possible to avoid data loss by storing the current IDATG project as XML file.

To restore this data, the menu item “Restore Designed Test Cases” can be used in TEMPPO Test Manager. This will cause IDATG to open a file dialog, where the previously saved XML file containing the IDATG project can be selected. After pressing "Save" in IDATG the data can be transferred to TEMPPO Test Manager.

11.1.2 Transferring data to TEMPPO Test Manager via XML interface

As an alternative to calling IDATG directly from within TEMPPO, there is also the possibility to transfer data using XML files. This approach can be useful if the tools are installed on different machines or if the direct interface cannot be used for some other reason.

- When converting test cases, just choose '**XML for TEMPPO Test Manager**' as **Output Format**.
- The tests are saved as XML file and can now be imported into TEMPPO Test Manager using the menu '**Test Structure|Import Structure|From XML Document…**'

Please note that test cases are only marked as 'Automated' if you have already exported them as automation scripts for a test execution tool. Otherwise, they are marked as 'Manual'.

11.2 Interface to HP ALM - Quality Center

Exporting test cases to HP ALM - Quality Center (HPQC) is possible via the Excel Add-in of HPQC. This is particularly useful for manual tests, but also possible for automated ones.

- Make sure that the HP ALM Client Registration Add-in and Excel Add-in are installed. See the HPQC Excel Add-in User Guide for more information.
- In IDATG, choose the task(s) for which test cases should be exported and click ‘**Convert Test Cases**’.
- As **Output Format**, choose '**Excel File for HP Quality Center**'. Also select the '**Test Script Directory**' in which the files shall be saved. Press '**OK**'.
- Due to a notorious Excel problem, importing data that contains both non-ASCII characters and line breaks within a cell is almost impossible. Non-ASCII characters can be imported from tab-separated text files, but not from CSV files. Line breaks can be imported from CSV files, but not from text files. The following trick solves this dilemma: IDATG stores the test cases in tab-separated text files but uses the .csv ending.
- This confuses Excel sufficently to prevent it from messing with the data. **Double-click the .csv file in the Windows Explorer or drag it into Microsoft Excel. Do NOT open it using Excel’s File->Open function or you will use all line breaks within a cell.** If you

change the file in Excel and want to save it, do NOT choose any CSV or TXT format but .xlsx.

- Select columns A-H in the rows you wish to export (but do not select the header row).
- Choose the menu '**Tools|Export to HP ALM**' or the equivalent cormand in your version of Excel. See the HPQC Excel Add-in User Guide for details.
- When the Excel Add-in asks you to map the columns to fields in HPQC, choose the following:

Excel Column	HPQC Field	Associated IDATG Data
A	Subject	Task Folder Hierarchy
B	Test Name	Task Name + Number
C	Description	Task Description
D	Type	"MANUAL" or "WR-AUTOMATED"
E	Status	Always set to "Imported"
F	Step Name (Design Steps)	Task Step Name
G	Description (Design Steps)	Task Step Instruction
H	Expected (Design Steps)	Task Step Expected Result

- The test cases are exported and should now be visible in HPQC. You may have to press '**Refresh**' in HPQC before the changes are displayed.

If you have updated the test cases in IDATG, just repeat the procedure. As long as the folder and task names did not change, the existing tests will simply be updated in HPQC. Otherwise, they will be imported as new tests into HPQC.

11.3 HTML / WinWord Interface

Whenever you want to get a detailed documentation of your project, IDATG provides a powerful feature: It is possible to export the entire GUI specification as HTML files **including screenshots as JPGs**! Just press the menu '**Generate | Generate HTML Documentation**' to reach the HTML generator.

Figure 34 - HTML Generator

Use the '**Browse...**' button to specify the target directory. Please note that all other *.htm* files in this directory will be deleted! If you wish that the documentation should include screenshots, check the box. Don´t worry if a bunch of **Window** and **Task Flow Editors** opens on your screen – this is necessary for recording the screenshots. After the generation, these editors will close automatically.

Which files are generated?

IDATG_Title.htm	The start page for your new HTML documentation
IDATG_GlobalAtt.htm	A list of the project's global attributes
IDATG_Hierarchy.htm	The window hierarchy in the form of a tree
IDATG_Metacond.htm	A list of the project´s meta conditions
IDATG_Project.htm	General project information

IDATG_Req.htm	A list of the project's global requirements
IDATG_Task.htm	Task hierarchy in the form of a tree
IDATG_TC.htm	Test case hierarchy in the form of a tree
WND_*WindowID*.htm	For each window with own title bar, lists of all children and transitions are generated. They contain detailed information about properties, attributes, conditions and actions.
WND_*WindowID*.jpg	For each window with own title bar, a screenshot including transitions is generated as a handy JPG file!!
TASK_*TaskID*.htm	For each task a list of all steps containing detailed information is generated.
TASK_*TaskID*.jpg	For each task, an image of the task flow is generated as JPG file.
TC_*TestcaseID*.htm	For each test case a list of all steps containing detailed information is generated.
TC_*TestcaseID*.jpg	For each test case, an image of the step sequence is generated.
Logo.jpg	The IDATG Logo that is used on the start page.

How can I convert the HTML files to WinWord?
While the HTML format has many advantages, its non-linear structure makes is difficult to get an overview. If you want the entire documentation in one single file that can easily be printed, it is recommended to convert it to a Microsoft ® WinWord file.

The installation package of IDATG contains a WinWord macro that performs this task for you. Just follow these steps:

1. Copy **Html2Word.doc** into the same directory where the HTML files have been placed.
2. Open the document in MS WinWord. If you should get a macro warning, select *Activate macros*.

In WinWord, press *Extras*|*Macro*|*Macros...* and execute the macro *Collect_HTML_Files.* This macro collects all HTML files in the directory and creates a well-structured WinWord document named **GUI_Specification.doc**. The document also contains the screenshots as well as page numbers and a table of contents!

12 Formal Specification Language

This chapter describes how the behavior and semantics of an application can be formally defined.

12.1 Designators

As has already been pointed out the basic concept of the IDATG language is the **step**. In order to describe a step, we need to define its trigger event, the pre-conditions and the effects (actions) of the step. However, it is quite evident that we also need some possibility to refer to variables and the properties of GUI objects.

Designators can be seen as variables that can be used in events, conditions and actions. They have a defined initial value which may change in the course of the generation process. All designators are written between '#' characters to avoid confusion with strings or operator names.

IDATG knows the following types of designators:

- **Global Attributes**

User-defined global variables can be edited with the **Attributes Editor**. They do not belong to a specific object and can be accessed with #:*AttributeName*#

- **User-defined Window Attributes**

User-defined attributes for windows can be edited like global variables with the **Attributes Editor**. Their name is preceded by the Window ID: #*WindowID:AttributeName*#

- **Pre-defined Window Attributes**

Pre-defined attributes for windows like #*WindowID:$Enabled*#, #*WindowID:$Visible*# etc. They always begin with a '$' sign, are imported automatically when using the **GUI Spy** and can be edited afterwards in the **Window Properties Editor**. A detailed list that shows which pre-defined attributes are available for each window type can be found in chapter 8.

- **Window Values**

The value (contents) of windows, like input fields or radio groups. To access this value, simply use the format #*WindowID*#. The initial value of a window can be edited in the **Window Properties Editor.**

- **Task Parameters**

If a task has parameters, their values can be accessed using #@*TaskName:ParameterName*#. In contrast to all other designators, the parameters of a task are only visible within the steps of the task itself. Not surprisingly, the default value can be set in the **Task Parameters Editor**.

- **Test Data**

For data-oriented testing, you can refer to a certain field of a data set using the syntax #~Set*Name:FieldName*#. During test case generation, the designator will be replaced by the value of this field in the current data record. The default value can be fixed in the **Data Field Editor**.
The ID and validity of the current data record can be referenced using the pre-defined attributes #~*SetName:$id*# (String) and #~*SetName:$valid*# (Boolean).

If you used the CECIL method for generating test data, you can even include references to the effects (#~*SetName:~EffectName*#) and effect variables (#~*SetName:*@*VarName*#):

Please note that is it not necessary for you to learn the various formatting rules by heart, IDATG provides a "Browse Designators" feature that handles this for you.

12.2 Event Language

Each mouse click or keyboard input that triggers a step is called an **Event**. IDATG provides a simple language that allows you to express these trigger events. When exporting test cases, the events are translated into the language expected by the selected GUI test execution tool. For API testing or for operations that are not covered by IDATG's event language, you can also enter test commands in the target language directly. The following table contains an overview that shows which functions can be used for the respective window types:

Event	CheckBox	ChildWindow	ComboBox	CustomWindow	DialogBox	GroupBox	Header	Image	InputField	Link	ListBox	ListView	MainWindow	Menu	MenuItem	PushButton	RadioButton	TabControl	Table	Text	ToolBar	TreeControl
Check	X										X	X			X							X
Click	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X	X
Close		X		X	X								X									
Expand																						X
Input			X						X										X			
Position		X		X	X								X									
Scroll		X		X	X				X		X	X	X						X			X
Select			X			X					X	X						X				X
Type	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X
Verify	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Wait	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X

The event can be entered in the **Step Editor** and always refers to the start window of the step. Depending on the function and the window type, several arguments have to be passed to the function. Optional parameters are enclosed by [ ] in the following.
The event language is not case-sensitive (*Click* and *click* are the same). However, it may be important to use the correct case in string constants that are directly passed to the capture-replay tool (e.g. *Select("McDonald")* may not be the same as *Select("mcdonald"))*.

Complex Arguments
In many cases, you may use complex expressions as arguments for an event. For instance, if you want to copy the contents of input field *#Field1#* into *#Field2#*, you can draw a transition from *#Field2#* and give it the event *Input(#Field1#)*. The same language as for conditions and action arguments is used for this kind of arguments.

Other examples:
Check(NOT #CheckBox1#) Set a check box to the contrary value of another check box
Verify(Value, #sum1# + #sum2#) Verify that a field contains the sum of 2 other fields

String Concatenation
You can use the string concatenation operator '&' to connect two or more arguments. The result is always a string, although the arguments may have any type.

Examples:
Input("Number: " & #Field1#")
If the current value of #Field1# was 25, the result would be Input("Number: 25")

Verify(Value, "Full name: " & #FirstName# & #LastName#)
This would result in something like Verify(Value, "Full name: Michael Randall")

12.2.1 Click

The function *Click* represents a mouse click on a window. The click can either be executed with the left (L) or right (R) mouse button and may either be a single (1) or double (2) click. The default is a single click on the left button. If you are using WinRunner, you may specify the index of a certain toolbar button. For tables, the row and column number have to be specified.

Click([Button], [Clicks], [X, Y])

> *Button:* L = left button, R = right button, default = L
> *Clicks:* 1 = single click, 2 = double click, default = 1
> *X,Y:* Coordinates relative to the upper left corner of the window (in pixels). Useful if you want to click on an object that cannot be recognized by the test execution tool (e.g. in a drawing area).

Examples: Click, Click(R), Click(L, 2), Click(L, 1, 20, 30)

For Toolbars: (only working for WinRunner, but not for SilkTest!)
Click(ButtonIndex, [Button])

> *ButtonIndex:* The numeric index of the toolbar button that should be clicked. The buttons are counted starting from the left. Note that WinRunner starts counting with 0.
> *Button:* L = left button, R = right button, default = L

Example: Click(0), Click(2, R)

For Tables:
Click(Row, Column, [Button], [Clicks])

Example: Click(2, 3, L, 2)

Note: For selecting a specific element from a list or checking a check box, the respective functions should be used instead of Click.

12.2.2 Type

Type means pressing a key or a combination of keys on the keyboard. For entering text into a field, *Input* should be used instead.

- Special key names (more than one character long) have to be written between <angled brackets> e.g. <Enter>. The brackets are not necessary for simple keys like a,3,$ etc.
- If two or more keys should be pressed SEQUENTIALLY, just write them one after the other: e.g. Type (“<Alt>x”)
- If two or more keys should be pressed SIMULTANEOUSLY, you have to combine them with ‘-‘: e.g. Type (“<Alt>-x”)
- It is allowed to combine both forms in one Type event: e.g. Type (“<Alt>-xy”) means “press ‘Alt’ and ‘x’ simultaneously, then release both keys and press ‘y’ ”.
- The following characters have to be preceded by a backslash (\): "-\

Examples: Type("A"), Type("<Esc>"), Type("\""), Type ("<Ctrl>-<Alt>-x"), Type (“a-bc”)

List of key names:

Function and Cursor Keys:

Esc, F1-F12, PrtScr, ScrlLock, Pause
Ins, Del, Home, End, PgUp, PgDn
Left, Right, Up, Down

Control Keys:

Note: If it is important whether the left or right key on the keyboard is pressed, add L or R to the name of the key, otherwise just use the simple name.

Shift, ShiftL, ShiftR
Ctrl, CtrlL, CtrlR
Alt, AltL, AltR, AltGr (on German keyboards)
Win, WinL, WinR, Menu (additional keys for Win95)

Main Keyboard:

Backspace, Tab, CapsLock, Enter

All other main keys can be expressed by the character itself.

Numeric Keypad:

<table>
<tr><td>NumLock</td><td>#/</td><td>#*</td><td>#-</td></tr>
<tr><td>#7
#Home</td><td>#8
#Up</td><td>#9
#PgUp</td><td rowspan="2">#+</td></tr>
<tr><td>#4
#Left</td><td>#5</td><td>#6
#Right</td></tr>
<tr><td>#1
#End</td><td>#2
#Down</td><td>#3
#PgDn</td><td rowspan="2">#Enter</td></tr>
<tr><td colspan="2">#0
#Ins</td><td>#.
#Del</td></tr>
</table>

12.2.3 Input

Input signifies text input into a field or table cell. For tables, the row and column number have to be specified. The following characters have to be preceded by a backslash (\): "\

For Input Fields and Combo Boxes:
Note that *Input* is not allowed for Combo Boxes that have the style DROPLIST.

Input(Value)

Value: The value that is entered into the field. It may be any STRING, NUM or DATE expression, but must match the type of the field. For instance, you cannot enter a STRING expression into a NUM field.

Examples: Input("MyText"), Input(#age# + 3)

For Tables:
Input(Row, Column, Value)

Value: The value that is entered into the table cell. Can be any STRING expression.

Example: Input(2, 3, "MyText")

12.2.4 Select

Select means clicking on a specific item that is contained in a window. Depending on the type of window, different parameters are expected. The following characters have to be preceded by a backslash (\): "\ (for TreeControls also |)

For Tab Controls:
Select("PageTitle")
PageTitle: The title of a tab page. The page must have been specified in the **Tab Control Editor** before.

Example: Select("General Options")

For Group Boxes (Radio Groups):
Select("RadioButtonCaption")
RadioButtonCaption: The caption of a radio button. The button must be positioned inside the group box.

Example: Select("Female")

For Combo Boxes, List Boxes, List Views:
You may either specify the selected item using its position or its text.

Select(Position, [Clicks])
Position: The position (index) of the item in the list. Can be any NUM expression or LAST for the last item in the list. Note that WinRunner expects a 0-based index, while SilkTest starts counting with 1.
Clicks: 1 = single click, 2 = double click, default = 1

Select(Text, [Clicks])
Text: The text of the item. Can be any STRING expression.
Clicks: 1 = single click, 2 = double click, default = 1

Examples: Select(3), Select(LAST), Select("MyItem"), Select(#Field1#), Select(1, 2)

For Tree Controls:
Select(Item, [Clicks])
Item: The path to the selected item starting from the root of the tree in the form *"Item$_1$|Item$_2$...|Item$_n$"*. The hierarchy levels are separated by '|'. Can be any STRING expression.
Clicks: 1 = single click, 2 = double click, default = 1

Examples: Select("RootItem"), Select("Grandparent|Parent|Child", 2), Select(#Field1#)

12.2.5 Check

Check sets a check box to a specific value. In contrast to a simple *Click* a mouse click is only performed if the box does not already have the desired value. Tri-state check boxes may also be set to a state called "dimmed" or "undetermined" (the box is displayed checked and grayed).

For Check Boxes and Menu Items:

Check(Value)
Value: Any BOOL expression or UNDETERMINED.

Example: Check(TRUE), Check(#Age# > 18)

For List Boxes and List Views:
In some applications check boxes are used as list items. You may either specify the item using its position or its text. Note: It depends on how these items are implemented whether the test execution tool will be able to access them or not!

Check(Position, Value)
Position: The position (index) of the item in the list. Can be any NUM expression or LAST for the last item in the list. Note that WinRunner expects a 0-based index, while SilkTest starts counting with 1.
Value: Any BOOL expression or UNDETERMINED.

Check(Text, Value)
Text: The text of the item. Can be any STRING expression.
Value: Any BOOL expression or UNDETERMINED.

Examples: Check(1, TRUE), Check(LAST, FALSE), Check(“MyItem”, UNDETERMINED)

For Tree Controls:
Check(Item, Value)
Item: The path to the checked item starting from the root of the tree in the form *"Item$_1$|Item$_2$...|Item$_n$"*. The hierarchy levels are separated by '|'. Can be any STRING expression.
Value: Any BOOL expression or UNDETERMINED.

Examples: Check("RootItem", TRUE), Check("Grandparent|Parent|Child", FALSE)

12.2.6 Expand

Expand is used for TreeControls and signifies expanding or collapsing the tree by clicking on the [+] or [-] symbol of a tree item. The following characters have to be preceded by a backslash (\): "\|

Expand(Item, Expand)

Item: The path to the expanded item starting from the root of the tree in the form *"Item$_1$|Item$_2$...|Item$_n$"*. The hierarchy levels are separated by '|'. Can be any STRING expression.

Expand: 0 = collapse item, 1 = expand item

Examples: Expand("RootItem",1), Expand("Grandparent|Parent|Child", 0), Expand(#Field1#, 1)

12.2.7 Position

Position can be used to change the size and position of a window. This is only possible if the window has a titlebar of its own.

Position(MINIMIZE)

Minimizes the window to an icon.

Position(MAXIMIZE)

Maximizes the window so that it fills the entire screen.

Position(RESTORE)

Restores size and position of the window after it has been minimized or maximized.

Position(RESIZE, Width, Height)

Resizes the window to the new width and height (in pixels).

Position(MOVE, X, Y)

Moves the upper left corner of the window to the new position (in screen coordinates).

Examples: Position(MINIMIZE), Position(RESIZE, 100, 200), Position(MOVE, 10, 20)

12.2.8 Scroll

Scroll can be used to scroll the client area of a window. It can be used for all window types that may have a scrollbar: Child Window, Custom Window, Dialog Box, Input Field, List Box, List View, Main Window, Table and Tree Control.

Note: This event is not necessary for SilkTest, because this tool scrolls GUI objects into view automatically.

Scroll(Direction, Clicks)

Direction: V = scroll in vertical direction, H = scroll in horizontal direction.

Clicks: The number of clicks on the scrollbar. Can be any number between -10000 and +10000 (a negative number means scrolling left/up, a positive number means scrolling right/down). Note that the number of clicks necessary to reach a specific object may vary depending on the size of the window or the number of list items.

Examples: Scroll(V, 1), Scroll(H, -10)

12.2.9 Close

Close is used to close a window by simulating a click on the **X** symbol in the titlebar. Naturally, the window must have a titlebar. *Close* should always be used instead of *Type("Ctrl-F4")* or *Type("Alt-F4")*, because otherwise some test execution tools show strange behavior.

Close
Closes the window. There are no parameters.

Example: Close

12.2.10 Wait

This command causes the test execution tool to wait until a window reaches a certain state. It is possible to wait until the window becomes enabled or until a certain text is displayed. *Wait* can only be used if the window is already displayed. If you want to wait for a window to appear on the screen, use the field '**Delay**' in the **Step Editor** instead.

Wait(Timeout, ENABLED*, Value)*
Timeout: The maximum time to wait in milliseconds (0-3600000). If the window does not become enabled after this time, an error is reported by the test execution tool.
Value: Any BOOL expression

Example: Wait(5000, Enabled, TRUE)

Wait(Timeout, CAPTION*, Text)*
Timeout: The maximum time to wait in milliseconds (0-3600000). If the text does not match after this time, an error is reported by the test execution tool.
Text: Any STRING expression

Example: Wait(1, Caption, "OK")

For Input Fields and Combo Boxes:
Wait(Timeout, VALUE*, Text)*
Timeout: The maximum time to wait in milliseconds (0-3600000). If the value does not match after this time, an error is reported by the test execution tool.
Text: Any STRING expression

Example: Wait(30000, Value, "Smith")

12.2.11 Verify

Verify events can be used to define additional verification steps e.g., in a task flow.

*Verify(*EXISTS*)*
Verify if a window is existing. Can be used for all window types except menus and Java group boxes. Currently not working for SilkTest.

Example: Verify(Exists)

*Verify(*ENABLED*, Value)*
Value: Any BOOL expression
Verify if a window is enabled or not. Can be used for all window types except menus and Java group boxes.

Example: Verify(Enabled, TRUE)

*Verify(*CAPTION*, Text)*
Text: Any STRING expression
Verify if a window has a certain caption (not the same as the value!). Can be used for all window types except menus and Java group boxes

Example: Verify(Caption, "OK")

*Verify(*FOCUS*)*
Verify if a window has the input focus
Can be used for all window types except menus and menu items. Also not allowed for windows with titlebar and windows without a parent.
Note: MicroFocus TestPartner doesn't support Focus-Verifications for HTML GUI elements. Verify-Focus steps for HTML GUI elements are skipped in test cases converted to the TestPartner format!

Example: Verify(Focus)

*Verify(*SELECTION*, Text)*
Text: Any STRING expression
Verify if a certain text is currently selected in a list. Can be used for combo boxes, list boxes and list views.

Example: Verify(Selection, "student")

12.2.11.1 Verifying the value of a window

For Check Boxes:
*Verify(*VALUE*, Value)*
Value: Any BOOL expression
Verify the status of a check box. The value UNDETERMINED may only be used for tri-state check boxes.

Example: Verify(Value, TRUE)

For Input Fields and Combo Boxes:
*Verify(*VALUE*, Value)*
Value: The value that is entered into the field. It may be any STRING, NUM or DATE expression, but must match the type of the field. For instance, you cannot verify if a STRING field contains a NUM expression.
Verify if the window contains the text. Cannot be used for combo boxes that have style "Droplist". You can verify the selection or the text of a list item instead.

Example: Verify(Value, "Smith")

For Combo Boxes, List Boxes, List Views:
*Verify(*VALUE*, Position, Text)*
Position: The position (index) of the item in the list. Can be any NUM expression or LAST for the last item in the list. Note that WinRunner expects a 0-based index, while SilkTest starts counting with 1.
Text: Any STRING expression
Verify if the list item at the given position has the specified text.

Examples: Verify(Value, 0, "student"), Verify(Value, LAST, "worker")

For Group Boxes:
*Verify(*VALUE*, "RadioButtonCaption")*
Verify if the button with this caption is currently selected. The button must be positioned inside the group box.

Example: Verify(Value, "Female")

For Tab Controls:
*Verify(*VALUE*, "PageTitle")*
Verify if the tab page with this title is currently selected. The page must have been specified in the **Tab Control Editor** before.

Example: Verify(Value, "General Options")

For Tables:
*Verify(*VALUE*, Row, Column, Text)*
Text: Any STRING expression
Verify if the specified table cell contains the text

Example: Verify(Value, 2, 3, "MyText")

12.3 Condition Language

12.3.1 Introduction

This section describes the expression syntax required for the condition parser.

Expressions are used for different purposes in IDATG:

1. the formulation of conditions for a step in the **Condition Editor**
2. the definition of arguments for actions in the **Action Editor**
3. the definition of arguments for events in the **Step Editor**
4. the definition of task parameters in the **Sub Task Editor**

The same syntax is used for all cases in order to keep the effort for getting familiar with the program as low as possible.
The parser accepts both upper and lower case letters, the usage of space characters between operator and operands is not necessary but possible, depending on the style preferred by the user. The same applies to brackets, they are only necessary to change the priority of operators.

For example, '5 + 3 * 2' would return 11, while '(5 + 3) * 2' gives 16.

The parser considers the mathematical and logical priority rules. In general, the numerical operations are executed first, then the comparisons and at last the logical operations. Therefore no brackets are needed for '10 = 5 * 2 AND 3 > -5'. Expressions are written in infix-notation, which means that binary operators stand between their two operands and unary operators before the operand. (e.g. 5 + 3, NOT #Dialog1:$Visible#).

There are no limitations regarding the complexity of the expression or the number of used brackets.
If you use expressions to formulate conditions they always have to return a BOOL value, since a condition can only be TRUE or FALSE.
Argument expressions have to return the type of value, that is required for the specific action.

12.3.2 Types

The condition parser of IDATG knows four basic types for values:

- **NUM** - an integer value (32 bit)
- **BOOL** - a boolean value, may be TRUE or FALSE
- **STRING** - a string (max. length = 255 characters)
- **DATE** - a valid date value in format DD.MM.YYYY
  The year may range from 0100 to 9999.

12.3.3 Operators

The operators accepted by the parser can be divided into four classes:

Logical Operators:

The basic program version knows the standard operators *AND, OR, XOR* and *NOT*.

OR is an 'inclusive OR', which is TRUE when at least one of its operands is TRUE.

XOR is an 'exclusive OR', that returns TRUE if exactly one operand is TRUE and the other one FALSE.

Comparison Operators:

Operands can be compared using the operators *=, !=, <, >,* <= and >=.

While the last four are only allowed for numerical expressions and dates, the equal (=) and not equal (*!*=) signs can be used for all types.
The program decides automatically, whether to perform a mathematical or a string comparison.
There is no distinction between upper and lower case letters, so "TExt = text" would return TRUE.

Numerical Operators:

You can use the basic mathematical operators *+, -,* * and */*.
Note that all numbers are integers and division results may get truncated. The character '-' can also be used as a unary operator for negations (e.g. -(5+3)).

12.3.4 Operands

There are three possible types of operands:

Constant values:

The notation depends on the type of the value.

- NUM values are written as usual (45, -3),
- BOOL values are TRUE or FALSE
- STRINGs are written between quotation marks ("text", "Jerry Steiner"). A backslash (\) causes the next character to be interpreted as text (e.g. "te\"xt")
- DATE values are written as DD.MM.YYYY (e.g. 08.03.1994, 29.02.2000)

Designators (Variables):

Designators can be addressed by writing the name between '#' characters (e.g. *#Name#).* It is important that each designator has the type required by the expression operators.

For example, it is not possible to compare the designator *#HumanResources:Mode#* with the constant value 5, if it has been defined as a STRING variable.

For further information, please consult the section about designators.

Composed expressions:

Since there is no complexity limitation for expressions, it is possible to use operands that are composed expressions and contain operators themselves.

For example, *'#Name# = "Mr. Holmes"'* may be passed to any logical operator and *'(#Age# * 3) + 5'* to any numerical or comparison operator.

12.3.5 Formal Syntax Description

Semantic Condition:
<Boolean Expression>

Boolean Expression:

TRUE	|
FALSE	|
<Boolean Designator>	|
<Boolean Expression> AND <Boolean Expression>	|
<Boolean Expression> OR <Boolean Expression>	|
<Boolean Expression> XOR <Boolean Expression>	|
NOT <Boolean Expression>	|
<Boolean Expression> = <Boolean Expression>	|
<Arithmetic Expression> = <Arithmetic Expression>	|
<String Expression> = <String Expression>	|
<Date Expression> = <Date Expression>	|
<Boolean Expression> != <Boolean Expression>	|
<Arithmetic Expression> != <Arithmetic Expression>	|
<String Expression> != <String Expression>	|
<Date Expression> != <Date Expression>	|
<Arithmetic Expression> < <Arithmetic Expression>	|
<Date Expression> < <Date Expression>	|
<Arithmetic Expression> > <Arithmetic Expression>	|
<Date Expression> > <Date Expression>	|
<Arithmetic Expression> <= <Arithmetic Expression>	|
<Date Expression> <= <Date Expression>	|
<Arithmetic Expression> >= <Arithmetic Expression>	|
<Date Expression> >= <Date Expression>	|

Arithmetic Expression:

<Number>	|
<Arithmetic Designator >	|
<Arithmetic Expression> + <Arithmetic Expression>	|
<Arithmetic Expression> - <Arithmetic Expression>	|
<Arithmetic Expression> * <Arithmetic Expression>	|
<Arithmetic Expression> / <Arithmetic Expression>	|
- <Arithmetic Expression>	|
(<Arithmetic Expression>)	

String Expression:

<String>	|
<String Designator >	|
(<String Expression>)	

Date Expression:
<Date> |
<Date Designator > |
(<Date Expression>)

Number:
[0-9]+ |
(<Number>)

String:
“[a-z0-9]*“ |
(<String>)

Date:
DD.MM.YYYY |
(<Date>)

Boolean Designator:
#<Name of a boolean attribute># |
(<Boolean Designator>)

Arithmetic Designator:
#<Name of a numeric attribute># |
(<Arithmetic Designator>)

String Designator:
#<Name of a string attribute># |
(<String Designator>)

Date Designator:
#<Name of a date attribute># |
(<Date Designator>)

Priority of operators (in descending order):
( ) (Brackets), - (Sign), NOT, /, *, - (Minus), +, >=, <=, >, <, !=, =, AND, XOR, OR

12.4 Action Language

Actions are simple functions like calling a window, setting a designator to a new value etc. and are necessary to obtain a complete specification of the GUI behavior. Depending on the type of function, they can have various arguments. Arguments have the same syntax as conditions and can therefore also be complex expressions.

For example: *SetInputField(#Age#, 5 + (3 * #Aboutbox:Calls#)).*

The contents of windows is set with special actions like *SetInputField(Name, Value), SetRadioGroup(Name, Value)* etc. Other designators can be set to a new value with the action *SetAttribute(Name, Value)*.

The following actions are available:

Action Name	**Arguments**	**Description / Example :**
OpenWindow	*Name (WindowID)*	Open the window which is defined by the ID. The window is made visible and enabled automatically. e.g. *OpenWindow(#HumanResources#)*
OpenModalDialog	*Name (DialogBoxID)*	Open the Dialog Box which is defined by the ID as a modal dialog which means that no other windows can be used while this window is open (except its own children). The window is made visible and enabled automatically. e.g. *OpenModalDialog(#NameMissing#)*
CloseApplication	*None*	Close the current application, the end of every test case. At least one transition with this action has to be defined! e.g. *CloseApplication()*
CloseWindow	*Name (WindowID)*	Close the window which is defined by the ID. e.g. *CloseWindow(#HumanResources#)*
GotoDataRecord	*Dataset (DataSetName)* *RecordID (String)*	Move the record pointer of the data set to the selected record. e.g. *GotoDataRecord(#~Person#, "v01")*
NextDataRecord	*Dataset (DataSetName)* *RecordType (V, I, or A)*	Move the record pointer of the data set to the next record of the selected type (V=Valid, I=Invalid, A=All). If there are no more records, the pointer is reset to the first one. e.g. *NextDataRecord(#~Person#, v)*
ResetDataRecord	*Dataset (DataSetName)* *RecordType (V, I, or A)*	Reset the record pointer of the data set to the first record of the selected type (V=Valid, I=Invalid, A=All). e.g. *ResetDataRecord(#~Person#, i)*
SetAttribute	*Name (Designator)* *Value (Undetermin. Type)*	Set the value of an attribute. The type of the value depends on the attribute. e.g. *SetAttribute(#IDD_HUMAN:DBEmpty#, True), SetAttribute(#IDD_HUMAN:$caption#, "Personal Data")*

Action Name	**Arguments**	**Description / Example :**
SetCheckBox	*Name (CheckBoxID)* *Value (Bool or 'Undetermined')*	Set the value of a Check Box to True or False. Tri-State Check Boxes can also be set to the state Undetermined. e.g. *SetCheckBox(#PHD#, True)*
SetComboBox	*Name (ComboBoxID)* *Value (String, Num or Date)*	Set the value of a Combo Box. e.g. *SetComboBox(#Profession#, "student")*
SetInputField	*Name (InputFieldID)* *Value (String or Num or Date)*	Set the value of an Input Field. e.g. *SetInputField(#Name#, "Lewis")*
SetListBox	*Name (ListBoxID:$row)* *Value (String)*	Set the value of a row in a List Box. The row number can be an arbitrary integer. e.g. *SetListBox(#Listbox1:$3#, "text")*
SetListView	*Name (ListViewID:$row)* *Value (String)*	Set the value of a row in a List View. The row number can be an arbitrary integer. e.g. *SetListView(#Listview1:$3#, "text")*
SetRadioGroup	*Name (GroupBoxID)* *Value (RadioCaption)*	Set the value of a Radio Group. Note: The value is the caption of the active radio button. e.g. *SetRadioGroup(#Sex_GRP#, "Male")*
SetTabControl	*Name (TabControlD)* *Value (String)*	Set the value of a Tab Control. The value is the title of the tab page that should be selected. e.g. *SetTabControl(#Tab1#, "Page1")*
SetTableCell	*Name (TableID:$row,column)* *Value (String)*	Set the value of a single cell in a Table. The position of the cell has to be specified by the row and column number which may be arbitrary integers. e.g. *SetTableCell(#Table1:$2,4#, "text")*

13 Literature

IEEE COMPSAC'98	IDATG: An Open Tool for Automated Testing of Interactive Software
IEEE ICIPS'98	Intelligent Test Case Generation for Graphical User Interfaces
QUALITY WEEK'98	IDATG: Integrating Design and Automated Test Case Generation
MERCURY'99	IDATG: Intelligent GUI Test Case Generation
ICSTEST'03_1	Mohacsi S.: Minimizing Test Maintenance Costs through Automated Test Case Generation
ICSTEST'03_2	Pill, D.: Avoiding the Oxymoron of Programming Tests
ICSTEST'05	Mohacsi S.: A Unified Framework for API and GUI Test Automation
QA&TEST'06	Mohacsi S.: Test Automation in Space Projects
IEEE ICST'08	Beer A., Mohacsi S.: Efficient Test Data Generation for Variables with Complex Dependencies
VALID 2010	Mohacsi S., Wallner J.: A Hybrid Approach for Model-based Random Testing
EuroSTAR 2012	Mohacsi S.: "15 Years of Evolving Model-Based Testing - An Experience Report "
QUEST 2014	Mohacsi S.: "Model-Based Testing – the Key to Efficient Test Automation"

14 Glossary

Acceptance Test	See User Test
Action	Actions express the changes of the GUI that are produced by a certain step. For instance, a step may set the contents of an input field to a new value or disable a button. They can be defined with the **Action Editor**.
AUT	Application under Test
Behavior of the GUI	The dynamic behavior of a GUI is represented by a state-transition diagram. A stimulus (e.g. mouse click, key entry) changes the state of the GUI (e.g. the focus moves on the screen, a button becomes enabled). State transitions can be defined with the **Window Editor**.
Black-box Test	Black-box testing refers to the practice of verifying the expected behavior of a component based solely on its specification (i.e. without knowledge of its underlying implementation).
Capture/Replay Tool	A tool that is able to capture user actions, save them in test scripts, replay these scripts (by interacting with associated GUI-components) and verify the test results. Errors can only be found if they affect the GUI (e.g. through an error message). IDATG generates test scripts for the tools SilkTest (MicroFocus), TestPartner (MicroFocus), and WinRunner (HP).
Condition	A step can depend on one or more semantic conditions that have to be fulfilled before the step can be performed. IDATG provides a language for specifying semantic conditions that is easy to learn and very intuitive. It is possible to make references to the current state or contents of windows and to perform arithmetic, Boolean and string operations. Conditions can be defined with the **Condition Editor**.
Coverage	The test coverage expresses which percentage of the application is covered by test cases. It is a criteria for the completeness of a test phase, only if a specific test strategy is linked to a specific type of coverage. IDATG supports the following types of test coverage: Test strategy — Coverage Graph-oriented testing — Step (C0) and connection (C1) coverage Data-oriented testing — Valid and invalid data record coverage Transition testing — Transition coverage
DAO	Data Access Objects, a widely used database interface.
DAPI	Database Application Programming Interface
DB	Database
Defect	A defect is a situation, where the software does not perform as the user expects. In case of a defect it is not relevant whether the cause of the error stems from coding, design, specification, or requirements definition.
Designator	Designators can be seen as variables that can be used in events, conditions and actions. Most of them represent the contents or certain properties of GUI elements. Examples: #WindowID:$Enabled#, #WindowID:MyVariable#
Event (State-Transition Diagram)	Each state transition is triggered by an event (e.g. mouse click, key entry). Events are defined in the **Step Editor**.
Framework (Development Process)	A framework is a setting of basic principles and concepts that describes what the development of interactive systems should be

	focused on. It provides a number of perspectives for development and defines the relationships between those perspectives.
Functional Test	See Task-Oriented Test
GUI	Graphical User Interface
GUI Map	A file containing information about the layout and properties of GUI objects. Capture/replay tools require a GUI Map for executing a test script.
GUI Spy	A tool that is able to record GUI objects and their properties directly from the screen. A **GUI Spy** is used e.g., in IDATG for importing layout information and in capture/replay tools for generating the GUI Map.
HTML	Hyper Text Markup Language
HW	Hardware
ID	Identification
IDATG	Integrating Design and Automated Test case Generation
IE	Internet Explorer, popular internet browser from Microsoft
Integration Test	The testing of modules, programs, subsystems and even systems to prove that they interact properly. The common link among modules, programs, subsystems, etc. is that they can both share data globally and locally defined data through specially designed and constructed interfaces [Mosley, 2000].
JDK	Java Development Kit
JRE	Java Runtime Environment
JVM	Java Virtual Machine
MB	Megabyte (1.048.576 byte)
Meta-Condition	If a condition appears more than once in the GUI specification, it can be defined as a meta-condition. A M.C. can be used in other conditions like a macro simply by referring to its ID. They can be defined with the **Meta Condition Editor**.
MFC	Microsoft Foundation Classes, a set of pre-defined C++ classes that can be used for implementing a MS Windows GUI.
MHz	Megahertz (million cycles per second)
Module Test	The purpose of unit (module) testing is to prove that the individual units of the software function as they were intended. The software developer who built the unit under test should conduct the unit test [Mosley, 2000].
ODBC	Open DataBase Connectivity
PC	Personal Computer
QTP	HP QuickTest Professional, Capture/Replay Tool for automatic test execution.
Regression Test	The fundamental regression testing objective is to assure that all application system features remain functional after the introduction of corrections and enhancements of the production system. A second objective is to test any new corrected, or enhanced system features. A third objective is to assure that the system documentation is kept current [Mosley].
SilkTest (MicroFocus)	Capture/Replay Tool for automatic test execution.
SIS	System Information String containing data that uniquely identifies your

	PC. Generated by the IDATG Key Manager.
TEMPPO Designer	Synonym for IDATG
TEMPPO Test Manager	Test Execution, Managing, Planning and rePorting Organizer. A popular test management tool.
State-Based Test	See Transition Test
State	In IDATG, every window is seen as a state. The active state is determined by the current focus position, it changes as the user navigates through the GUI. Child windows can be seen as sub-states, parent windows as super-states.
State Transition	See Transition
State-Transition Diagram	A dynamic model represented as a diagram consisting of states and transitions. In IDATG, a state-transition diagram is used to represent the GUI behavior.
Step	The step is the basic term of the IDATG language and signifies a transition from one state of the GUI to another. A step can be described by the following information: • The event that triggers the step (usually a user input e.g., a mouse click). • The semantic conditions that must be fulfilled before the step can be executed (e.g., a certain button must be enabled). • The actions executed during the step (e.g. a window opens or a button becomes disabled). • Start and destination window of the step (in other words, the focus position before and after the step). There are 3 different types of steps: Transitions, Task Steps and Test Steps
SW	Software
System Test	See Task-Oriented Test
Tag	A label for the identification of GUI-elements by the capture/replay tool. Tags are generated automatically by IDATG.
Task	A task is a functional requirement of the specified GUI. Tasks are usually listed in the software requirements specification, where they are organized in a hierarchical tree structure.
Task-Oriented Test	During task-oriented (functional, system) testing, the application is seen from the users´s perspective. Task-oriented test cases are based on the software requirements specification.
Task Coverage	Specifies the percentage of an application´s tasks that are covered by test cases.
Task Flow	The task flow of a task is a directed graph without cycles that shows the sequence of steps that is necessary to perform the task. If there is more than one possibility to fulfill a task, the graph can have various branches.
Task Step	A single step of a task flow. It may either represent an atomic user action like clicking a button or refer to a complete sub task.
TC	Test Case
TCG	Test Case Generation
Tcl	Tool Command Language
Test Case	According to the standard 610.12-1990 by IEEE a test case is defined

	as follows: A set of inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular program path or to verify compliance with a specific requirement.
TestPartner (MicroFocus)	Capture/Replay Tool for automatic test execution.
Test Step	A single step of a test case. Each test step represents a user action on a certain GUI object.
Test Case Execution	The execution of a test case by a human user or capture/replay tool followed by the verification of the results.
Test Case Generator	A tool that automatically generates test cases based on a formal specification of a system.
Test Package	A test package (TP) is a set of test cases that logically belong together. For instance, a TP may contain all test cases for a certain task and its sub tasks. TPs help to group test cases into a clear test structure. When IDATG converts test cases into WinRunner or SilkTest scripts, this structure is reflected by the generated files and directories.
Transition	A type of → Step. In contrast to task steps, a transition is not part of a task flow. When generating test cases, IDATG tries to find a valid sequence of transitions rather than using the pre-defined sequences represented by the task flows.
Transition Coverage	Specifies the percentage of an application´s state transitions that are covered by test cases.
Transition Test	The aim of transition testing is to cover each state transition at least once. Before a transition can be tested, all conditions that have been defined for it have to be fulfilled.
TSC	Test Support Center
UI	User Interface
Unit Test	See Module Test
User/Acceptance Test	Acceptance testing is a type of system testing to demonstrate that the system meets the user requirements. It is a validation process.
Visual C++	The Microsoft development tool for C++. It includes a collection of pre-defined classes (MFC) for implementing MS Windows GUIs.
Window	Graphical User Interfaces consist of objects called windows. There is no generally accepted definition for this term, therefore it is often used with different meanings. For instance, according to the notation of the capture/replay tool WinRunner only the top-level parts of the GUI are called ‘windows‘, while the others are called ‘objects‘. On the other hand, MS Windows uses the term ‘window‘ for all parts of the GUI, regardless of their position in the GUI’s hierarchy. This means that dialogs, buttons, input fields, and even static texts are equally seen as windows. This point of view is not only simpler but also reflects better the internal functionality of today’s operating systems. Therefore, also the IDATG formalism denotes all types of GUI objects as windows.
WinRunner (HP) **WR**	A capture/replay tool for automatic test-case execution